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TECHNICAL REPORT

NO. 12910

Military Adaptation of Commercial Items (MACI)

Laboratory Evaluation of the Code E-430 Engine

FEBRUARY 1984

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The project determined the military adaptability of the Code E-430 engine through laboratory testing and evaluation. The engine was installed in a dynamometer test cell at US Army Tank-Automotive Command (TACOM) and conventional dynamometer testing procedures were used to determine basic engine characteristics. The characteristics determined were: full-load performance, fuel economy at full-load and part-load, engine oil consumption, engine heat rejection, and exhaust smoke density.

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During pre-endurance testing, the Code E-430 engine produced 170 observed kW (227.9 BHP) at full-load, at rated speed of 3000 RPM. The maximum torque during full-load operation was 609 Nm (449 lb-ft) at 1800 RPM. Minimum brake specific fuel consumption at full-load occurred at 2200 RPM and was 221 g/kWH (0.363 lb/BHP-HR).

Part-load fuel economy evaluation demonstrated that the minimum (overall) brake specific fuel consumption was 203.8 g/kW-hr (0.335 lb/BHP-hr).

Maximum full-load brake specific heat rejection measured .659 W/W (28.0 BTU/BHP-MIN) at 1400 RPM. The total heat rejected was 101.8 kW (5789 BTU/MIN) at 3000 RPM.

The total lube oil consumption during the 400-hour NATO endurance test was 15.42 kg (34 lb). Smoke density, measured at the end of test was found to have a maximum value of 2.4 on the Bosch smoke meter scale. (4.5 maximum permissible limit).

After the NATO Endurance Test the engine produced 174.3 observed kW (233.8'BHP) at full-load and rated speed (3000 RPM). The maximum torque was 618 N-m. (456 lb-ft) at 1800 RPM.

Following the test, visual inspection indicated that the major engine parts were in good condition.

The CODE E-430 engine successfully completed the 400-hour NATO endurance test. It accumulated a total of 494 hours.

PREFACE

This test program was supervised and conducted by the US Army Tank-Automotive Command, R&D Center, Propulsion Systems Division, under CRN RU10013C in test cell No. 6 of Bldg. 212. The test was started on 29 Apr 82 and ran until completion on 30 Jul 82.

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1.0. INTRODUCTION

The Military Adaptation of Commercial Items (MACI) program was originated at TACOM in 1975. The program's objectives are selection and simulated field test evaluation of current advanced technology engines to replace or update military engines in current vehicle programs. Responsibility for engine testing was given to the Propulsion Systems Division.

2.0. OBJECTIVE

The test objective is to determine full- and part-load performance characteristics and engine durability through the standard 400-hour NATO test program (AEP-5 dated June 1980) using high (1±0.05 percent) sulfur fuel.

3.0. CONCLUSIONS

The engine performed satisfactorily throughout the 400-hour NATO endurance test and throughout the performance tests scheduled at 100-hour test intervals. The engine met manufacturers listed performance values of power, torque, fuel economy, and heat rejection. The 400-hour NATO endurance test was successfully completed. The engine accumulated a total of 494 operating hours.

4.0. RECOMMENDATIONS

Steps should be taken to determine and correct the cause of high blowby observed during the tests.

5.0. ENGINE SPECIFICATIONS

5.1. Test Material.

5.1.1. Engine

- Serial Number: 20227520
- Code: E-430
- Model: VTA-504-C
- Maximum Output (500 ft and 85°F (150m & 29°C)) - BHP (kW): 235 (175)
- Speed @ Maximum Output - RPM: 3,000
- Type: Compression Ignition; 4-cycle; 90° V; 8-Cylinder
- Aspiration: Turbocharged
- Bore-in (mm) x Stroke-in. (mm): 4.625 (117) x 3.750 (95)
- Displacement - in^3 (litre): 504 (8.3)
- Compression Ratio: 16.0:1
- Dry Weight (with Standard Accessories) - lb, (kg): 1,565 (711)

5.1.2. Lubricating Oil: Grade 30, MIL-L-2104-C
Referee Grade: 30
Imperial Oil Co.
(APPENDIX E)

5.1.3. Fuel: MIL-F-46162B (ME) (14 Aug 81)
0.95-1.05 percent Sulfur by Weight
(APPENDIX B)

5.2. Test Equipment.

Controls, equipment, and associated instrumentation of cell No. 6, Building 212, TACOM.

5.3. Test Procedure.

5.3.1. Propulsion Systems Division Test Program: Engine Operating Limits and Adjustments. (APPENDIX A)

5.3.2. NATO Test Specification: Allied Engineer Publication (AEP-5 June 1980, NATO Standard Engine Laboratory Test for Gas Turbine Engines and Diesel and Gasoline Engines. (APPENDIX D).

6.0. RESULTS AND DISCUSSION

6.1. Pre-endurance Test Performance Evaluation.

6.1.1. Full-load Performance. All data are presented as observed without corrections. The engine developed 170 observed kW (227.9 BHP) at its rated speed of 3,000 RPM. Peak torque was 609 N-m. (449 lb-ft) at 1,800 RPM. Performance details are presented in Figures 1 and 2 and on Table 1.

6.1.2. Part-load Performance. The minimum observed brake specific fuel consumption (BSFC) was 219.0 g/kW-hr (0.360 lb/HR-hr) at 1,800 RPM, at 70 percent load.

6.2. Performance and Endurance Evaluation During NATO Test.

6.2.1. Full-load Performance after 100 hours. The engine developed 172.1 kW (230.8 BHP) at 3,000 RPM. The maximum torque occurred at 1,800 RPM and was 621.0 N-m. (458 lb-ft). Peformance details are presented in Figures 3 and 4 and Table 2.

6.2.2. Full-load Performance after 200 hours. The engine developed 175.3 kW (235.1 BHP) at 3,000 RPM. The maximum torque occurred at 1,800 RPM and was 630.5 N-m. (465 lb-ft). Performance details are presented in Figures 5 and 6 and Table 3.

6.2.3. Full-load Performance after 300 hours. The engine developed 176.2 kW (236.3 BHP) at 3,000 RPM. The maximum torque occurred at 1,800 RPM and it was 631.9 N-m. (466.0 lb-ft). Performance details are presented in Figures 7 and 8 and Table 4.

6.2.4. Full-load Performance after 400 hours. The engine developed 174.3 kW (233.8 BHP) at 3,000 RPM. The maximum torque value was 617.9 N-m. (455.7 lb-ft)

at 1,800 RPM. Performance details are presented in Figures 9 and 10 and Table 5.

6.2.5. Endurance Test (400 hours). The engine successfully completed the endurance test. It accumulated a total of 494 hours.

6.2.6 Visual and Dimensional Inspection of Major Engine Components Following Endurance. At completion of the test, the engine was completely dissassembled, cleaned and all critical parts were visually examined, dimensionally checked and photographed. Visual inspection and measurements revealed that virtually all components were in satisfactory condition. Description of engine components and their condition follows (See APPENDIX F for related photographs and APPENDIX G for dimensional inspection sheets).

- o Pistons - Pistons and rings are in satisfactory condition. Rings have no breakage and are free to move in the ring grooves. Ring grooves are still tight. Piston skirts are clean.
- o Piston Pin - No visual wear.
- o Cylinders - Satisfactory condition with light scratching and wear indicated.
- o Crankshaft Main Journals - Satisfactory condition - some scratching is evident.
- o Crankshaft Rod Journals - Satisfactory condition - some scratching is evident.
- o Main and Rod Bearings - Some scratching and overlay breakthrough.
- o Cylinder Head Intake and Exhaust Valve Seats - Satisfactory condition.
- o Intake and Exhaust Valve Faces - Satisfactory condition - some light pitting is evident.
- o Camshaft - lobes and bearing surfaces are in satisfactory conditon.
- o Gears - Crankshaft, Camshaft, Oil Pump Drive and Injection Pump Drive are in good condition.

6.2.7. Engine Oil Consumption. Oil consumption during the test was recorded by using the method of adding oil to the engine as required before engine start-up. Oil consumption was light. Results are shown in Table 6.

6.2.8. Oil Spectrographic Analysis. Oil samples were taken at various intervals and forwarded to the Petroleum Field Office East, New Cumberland, Pennsylvania for analysis. Report findings met NATO requirements as shown in APPENDIX E.

6.2.9. Full-load Heat Rejection. Maximum full-load brake specific heat rejection measured 0.583 W/W (25 BTU/BHP-MIN) at rated speed of 3,000 RPM. The total heat rejected was 101.8 kW (5,789 BTU/MIN). Full-load heat rejection characteristics are shown in Figures 11 and 12.

6.2.10. Engine Smoke Density. Exhaust smoke samples were taken and evaluated with Bosch smoke density meter Model EFAW-68 before endurance and at each subsequent 100-hour period. Smoke reading values are shown on Table 7. The NATO test specification indicated that a smoke sample reading of 4.5. should not be exceeded during full-load performance test. No smoke reading exceeded this value.

6.2.11. Crankcase Pressure. The engine crankcase pressure at the start of endurance testing was 9.8 inches of water. During the 400 hours of testing, the pressure gradually climbed and reached a high of 17.4 inches of water at test completion. Results are shown in Table 8.

6.2.12. Fuel Map - Data shown in Figures 13 and 14.

6.2.13. Performance data sheets required by NATO specification. Data are shown in APPENDIX H.

FIGURE- 1
FULL LOAD PERFORMANCE (0 HOURS)

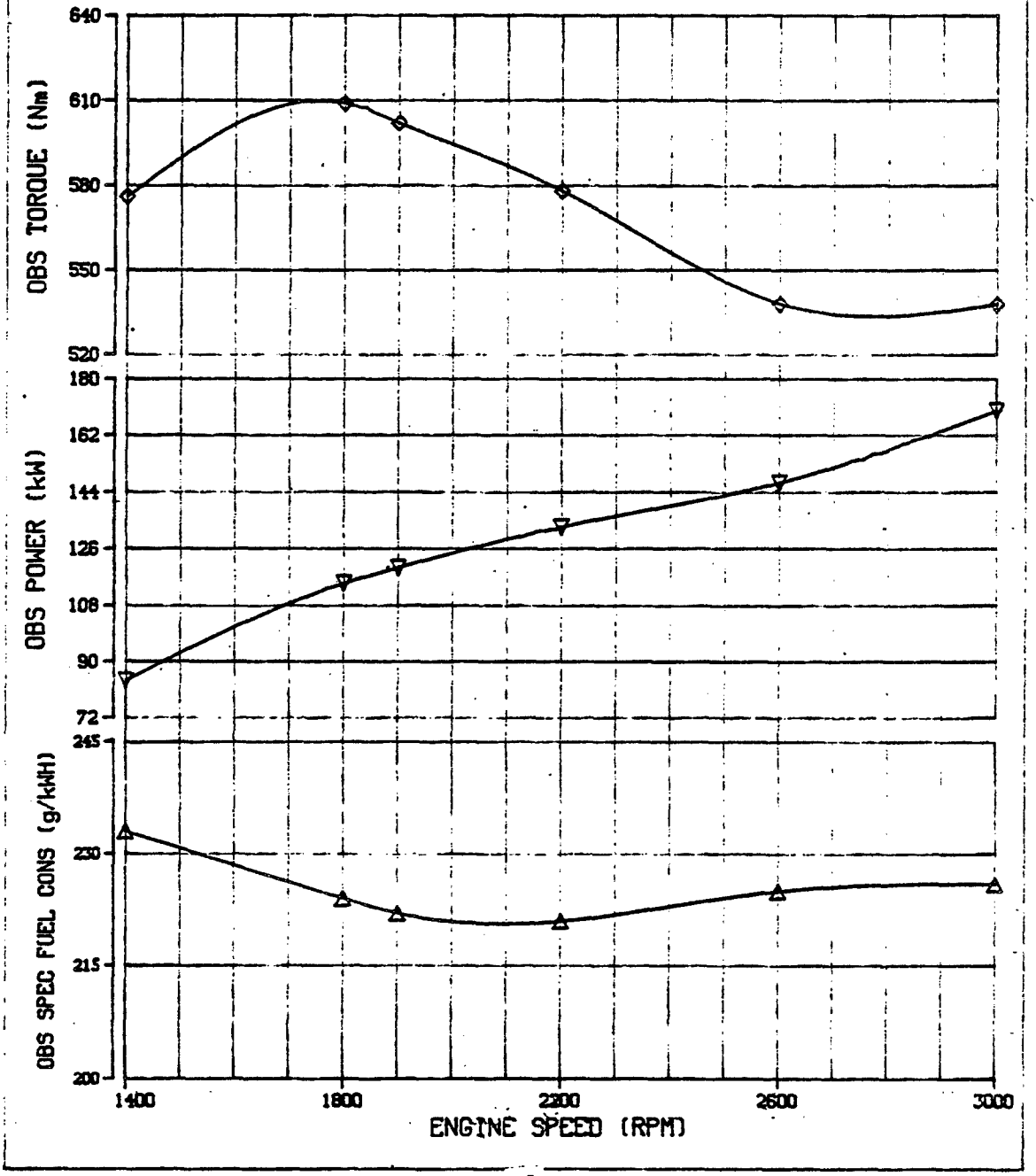


FIGURE-2
FULL LOAD PERFORMANCE (0 HOURS)

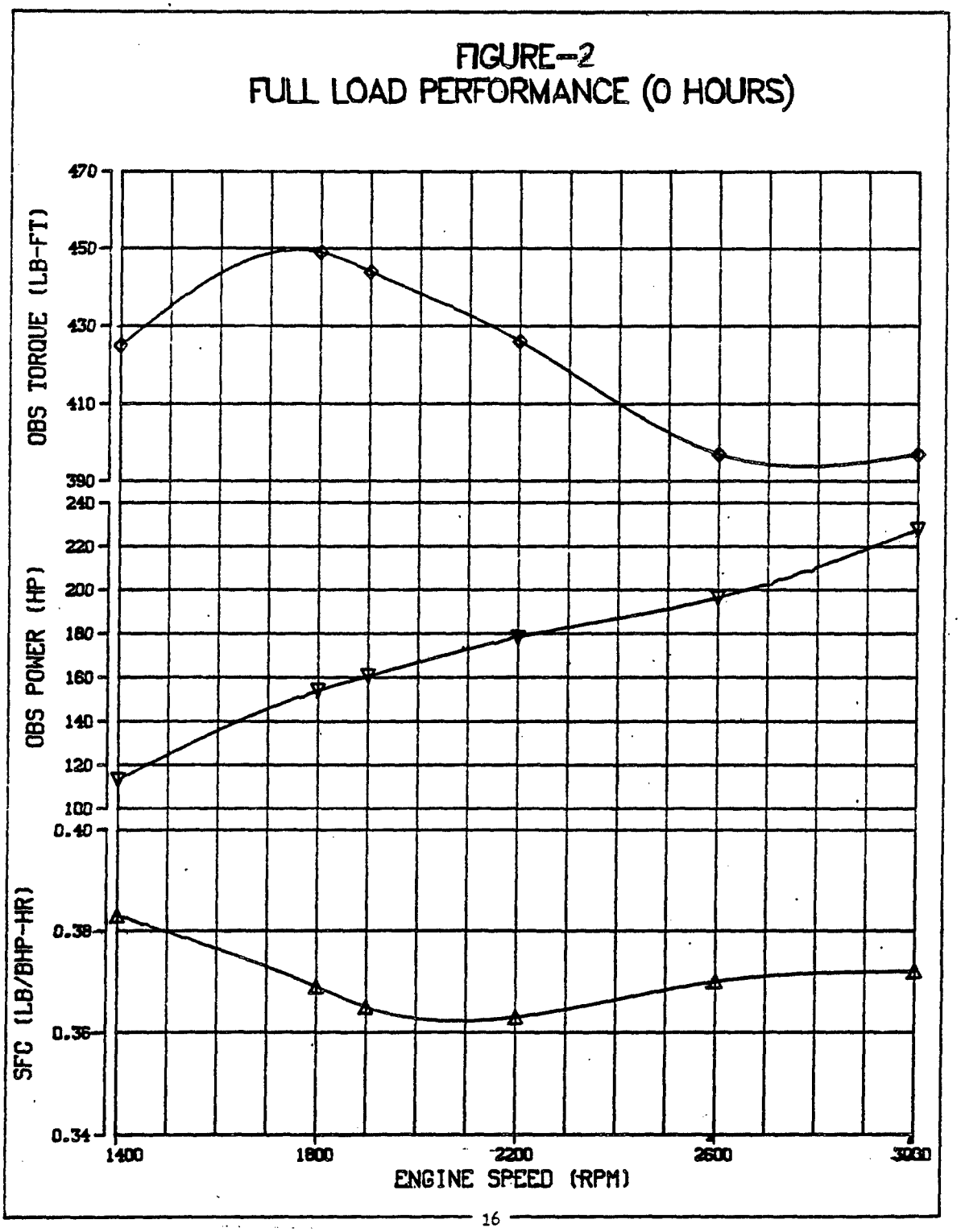


TABLE 1. Code E-430 Engine Full-Load Performance Data
Before Endurance - 0 Hours

SPEED (RPM)	OBSERVED TORQUE LB-FT (N-m.)	OBSERVED POWER BHP (kW)	OBSERVED FUEL FLOW LB/HR (KG/HR)	OBSERVED SPECIFIC FUEL CONSUMPTION LB/BHP-HR (g/kWH)	OIL SUMP TEMP °F (°C)	AIR CLEANER OUTLET TEMP °F (°C)	FUEL TEMP TO ENGINE °F (°C)	ENGINE COOLANT OUTLET TEMP °F (°C)
3,000	399	227.9	84.3	0.372	261.1	75.7	85.7	201.8
	(538)	(170.0)	(38.2)	(226)	(127.3)	(24.3)	(29.8)	(94.3)
2,600	397	196.5	72.7	0.370	253.0	75.6	83.3	201.8
	(538)	(147.0)	(33.0)	(225)	(122.8)	(24.2)	(28.5)	(94.3)
2,200	426	178.3	64.7	0.363	247.1	75.8	82.8	201.8
	(578)	(133.0)	(29.4)	(221)	(119.5)	(24.3)	(28.2)	(94.3)
1,900	444	160.7	58.6	0.365	244.3	75.9	81.9	201.9
	(602)	(120.0)	(26.6)	(222)	(117.9)	(24.4)	(27.7)	(94.4)
1,800	449	154.1	56.9	0.369	242.4	75.8	81.2	201.6
	(609)	(115.0)	(25.8)	(224)	(116.9)	(24.3)	(27.3)	(94.2)
1,400	425	113.3	43.4	0.383	228.1	75.0	78.3	201.0
	(576)	(84.0)	(19.7)	(233)	(108.9)	(23.8)	(25.7)	(93.9)

Applicable Test Condition/Range Variations

Intake Air Restriction -.77 to -8.1 in. H_2O (1.9 to 20.2 mbar)
Exhaust Gas Outlet Pressure .10 to 9.2 in. H_2O (.25 to 22.9 mbar)
Dry Air Barometer: 29.53 -in. Hg (999.9 mbar)

FIGURE- 3
FULL LOAD PERFORMANCE (100 HOURS)

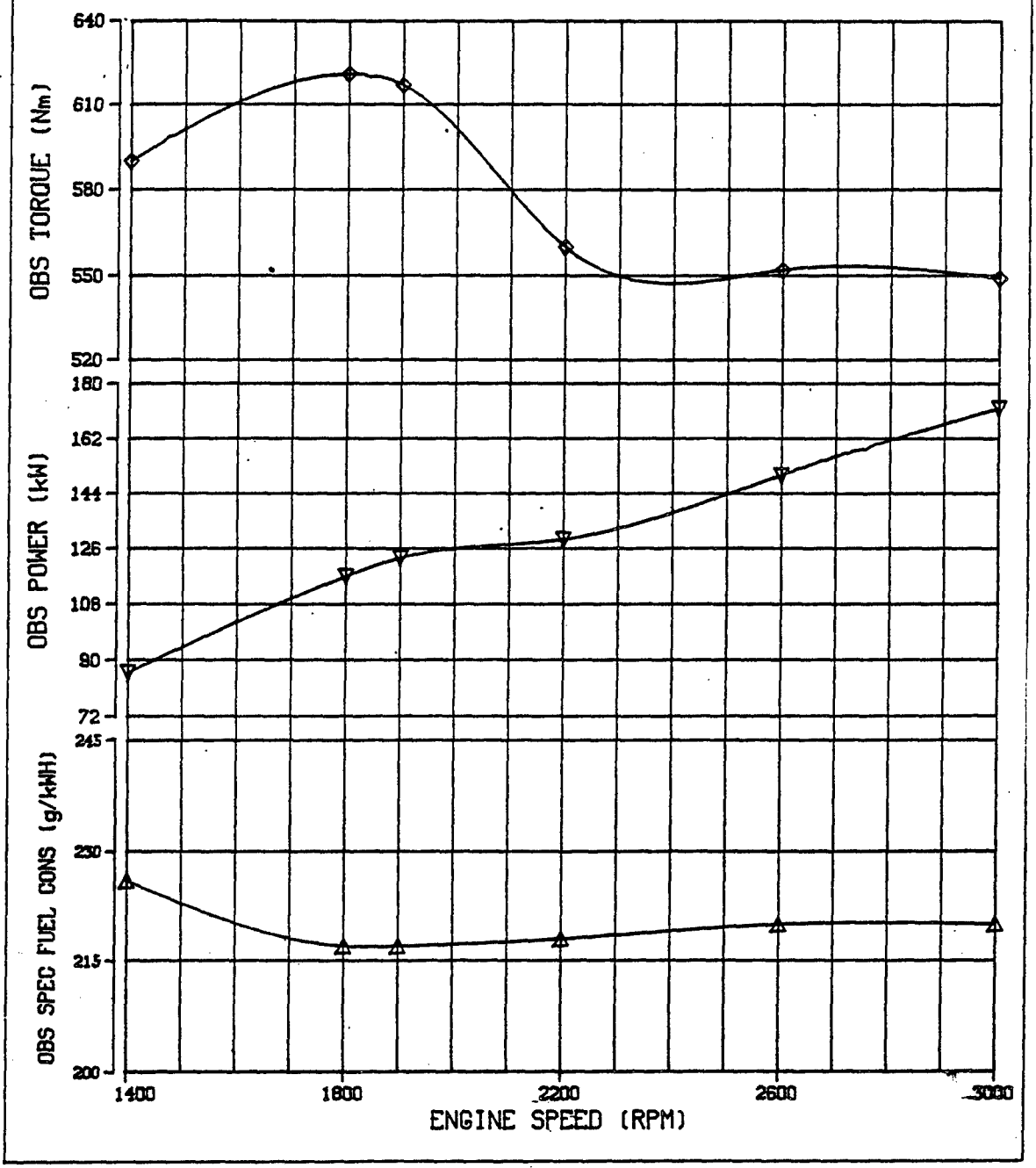


FIGURE-4
FULL LOAD PERFORMANCE (100 HOURS)

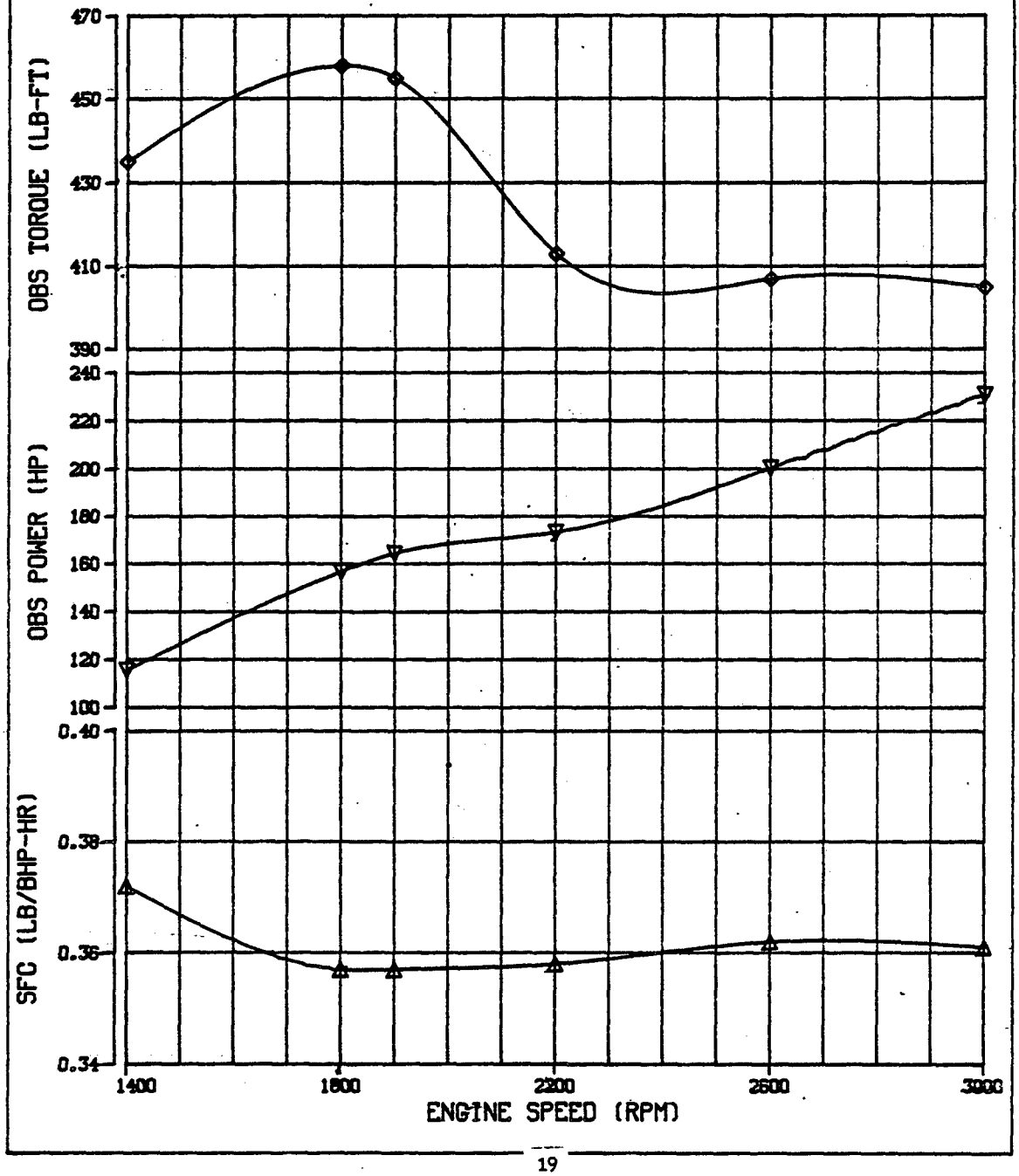


TABLE 2. Code E-430 Engine Full-Load Performance Data
Before Endurance - 100 Hours

SPEED (RPM)	OBSERVED TORQUE LB-FT (N-m.)	OBSERVED POWER BHP (kW)	OBSERVED FUEL FLOW LB/HR (KG/HR)	OBSERVED SPECIFIC FUEL CONSUMPTION LB/BHP-HR (g/kWH)	OIL SUMP TEMP °F (°C)	AIR CLEANER OUTLET TEMP °F (°C)	FUEL TEMP TO ENGINE °F (°C)	ENGINE COOLANT OUTLET TEMP °F (°C)
3,000	405	230.8	83.87	0.361	261.8	76.6	88.3	203.9
	(549)	(172.1)	(38.0)	(220)	(127.7)	(24.8)	(31.3)	(95.5)
2,600	407	200.5	73.09	0.362	255.4	77.7	84.0	203.9
	(552)	(149.5)	(33.2)	(220)	(124.1)	(25.4)	(28.9)	(95.5)
2,200	413	173.3	62.10	0.358	247.3	75.9	81.1	204.0
	(560)	(129.2)	(28.2)	(218)	(119.6)	(24.4)	(27.3)	(95.6)
1,900	455	164.4	58.80	0.357	244.8	75.5	83.8	204.1
	(617)	(122.6)	(26.7)	(217)	(118.2)	(24.2)	(28.8)	(95.6)
1,800	458	156.8	55.90	0.357	243.1	76.6	83.8	204.2
	(621)	(116.9)	(25.4)	(217)	(117.3)	(24.8)	(28.8)	(95.7)
1,400	435	115.6	43.06	0.372	231.5	76.9	83.8	204.8
	(590)	(86.2)	(19.5)	(226)	(110.8)	(24.9)	(28.8)	(96.0)

Applicable Test Conditions/Range Variations

Intake Air Restriction 1.4 to 5.5 in. H_2O (3.5 to 13.7 mbar)
Exhaust Gas Outlet Pressure .25 to 15.0 in. H_2O (.62 to 37.3 mbar)
Dry Air Barometer: 29.42 in. Hg (996.2 mbar)

FIGURE-5
FULL LOAD PERFORMANCE (200 HOURS)

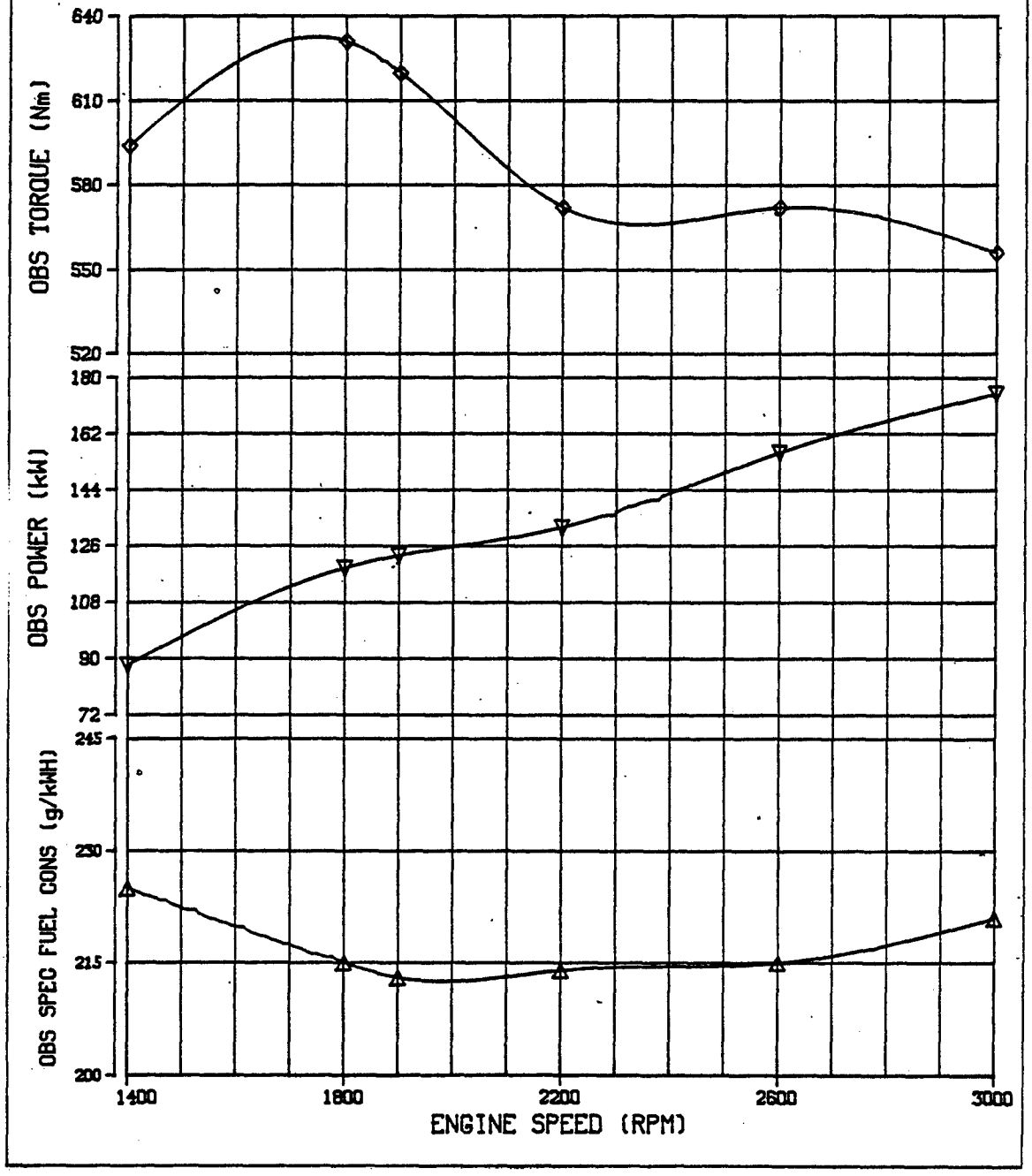


FIGURE-6
FULL LOAD PERFORMANCE (200 HOURS)

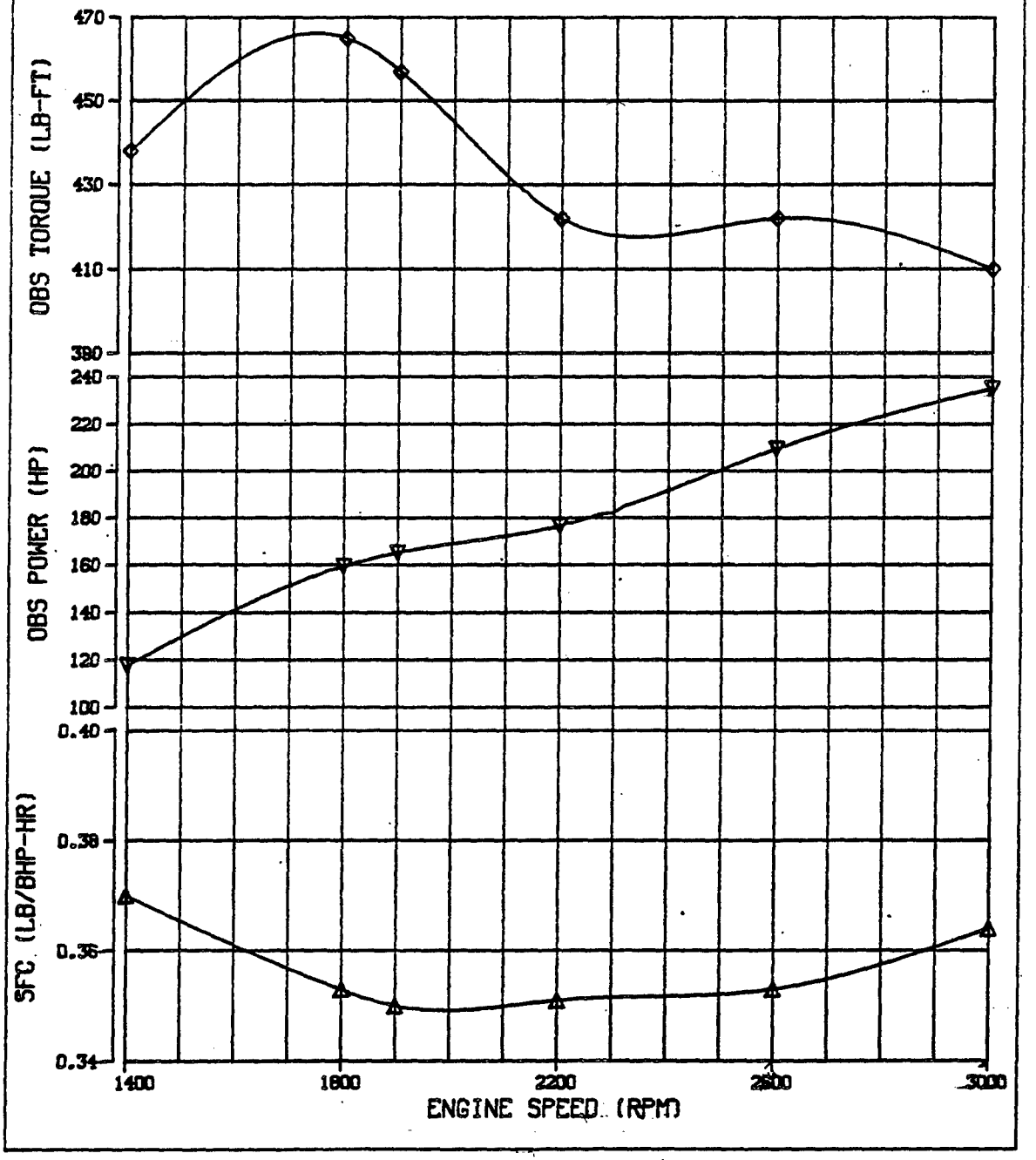


TABLE 3. Code E-430 Engine Full-Load Performance Data
Before Endurance - 200 Hours

SPEED (RPM)	OBSERVED TORQUE LB-FT (N-m.)	OBSERVED POWER BHP (kW)	OBSERVED FUEL FLOW LB/HR (KG/HR)	OBSERVED SPECIFIC FUEL CONSUMPTION LB/BHP-HR (g/kWH)	OIL SUMP TEMP °F (°C)	AIR CLEANER OUTLET TEMP °F (°C)	FUEL TEMP TO ENGINE °F (°C)	ENGINE COOLANT OUTLET TEMP °F (°C)
3,000	410	235.1	85.5	0.364	260.5	76.1	90.5	204.3
	(596)	(175.3)	(38.8)	(221)	(126.9)	(24.5)	(32.5)	(95.7)
2,600	422	209.5	74.0	0.353	250.7	77.1	87.1	203.7
	(572)	(156.2)	(33.6)	(215)	(121.5)	(25.1)	(30.6)	(95.4)
2,200	422	176.6	62.0	0.351	244.7	77.2	83.6	204.1
	(572)	(131.7)	(28.1)	(214)	(118.2)	(25.1)	(28.7)	(95.6)
1,900	457	165.2	58.0	0.350	241.4	77.6	83.4	203.7
	(620)	(123.2)	(26.3)	(213)	(116.3)	(25.3)	(28.6)	(95.4)
1,800	465	159.5	56.2	0.353	239.2	77.7	83.2	204.0
	(631)	(118.9)	(25.5)	(215)	(115.1)	(25.4)	(28.4)	(95.6)
1,400	438	117.8	43.6	0.370	230.7	77.7	81.9	(201.9)
	(594)	(87.8)	(19.8)	(225)	(110.4)	(25.4)	(27.7)	(94.4)

Applicable Test Conditions/Range Variations

Intake Air Restriction 1.1 to 3.9 in. H_2O (2.7 to 9.2 mbar)
Exhaust Gas Outlet Pressure .47 to 15.8 in. H_2O (1.2 to 39.3 mbar)
Dry Air Barometer: 29.62 in. Hg (1,002.9 mbar)

FIGURE– 7
FULL LOAD PERFORMANCE (300 HOURS)

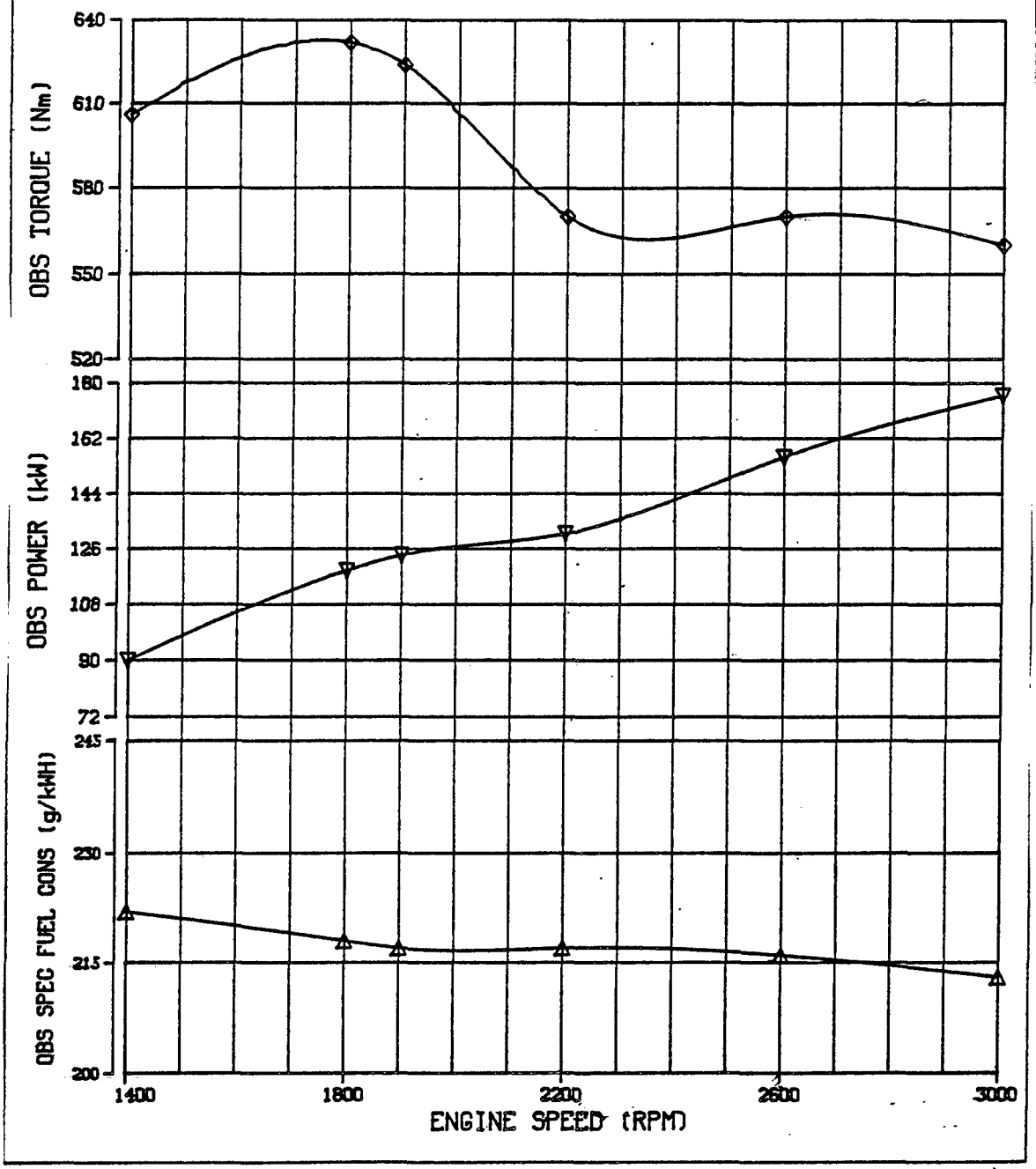


FIGURE-8
FULL LOAD PERFORMANCE (300 HOURS)

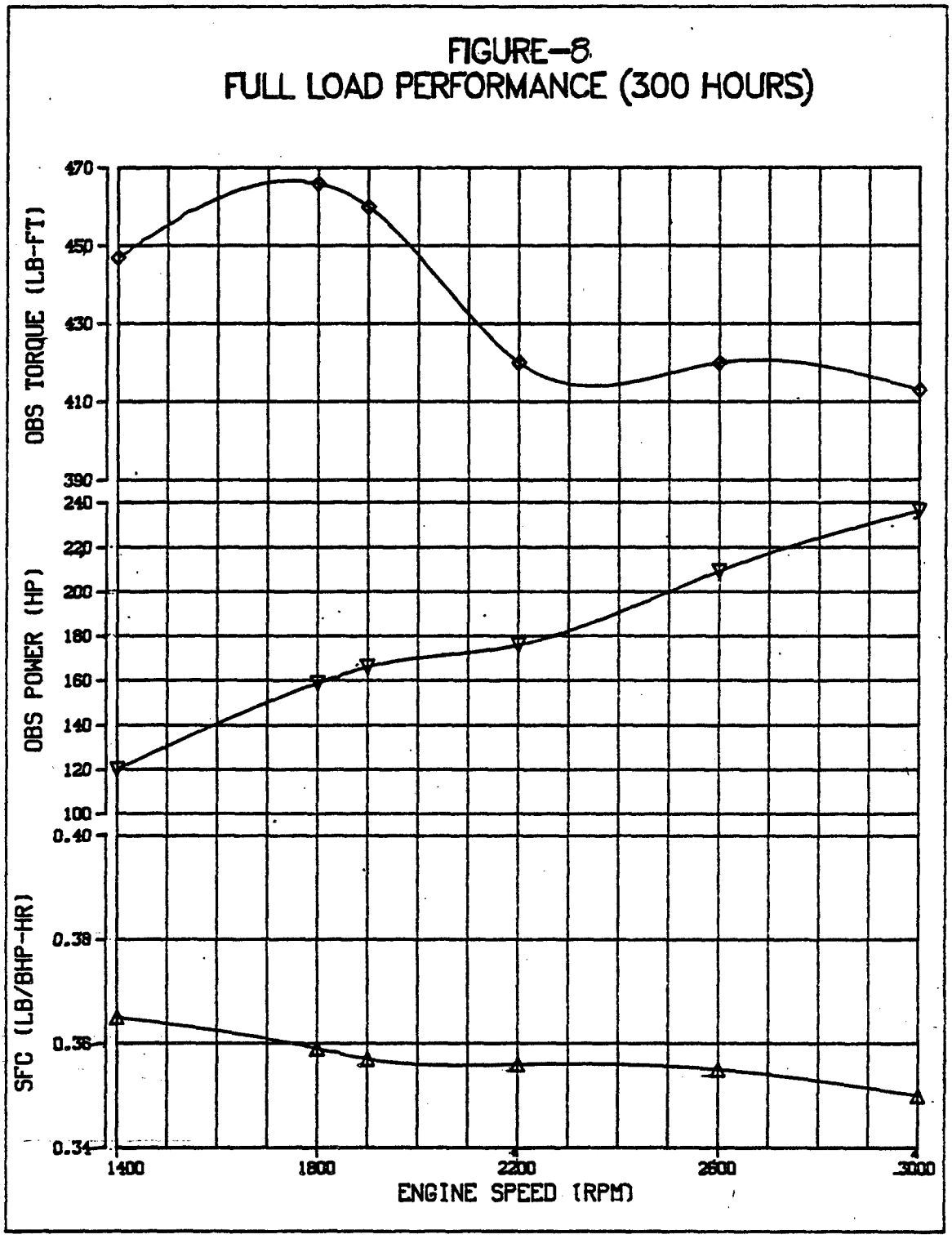


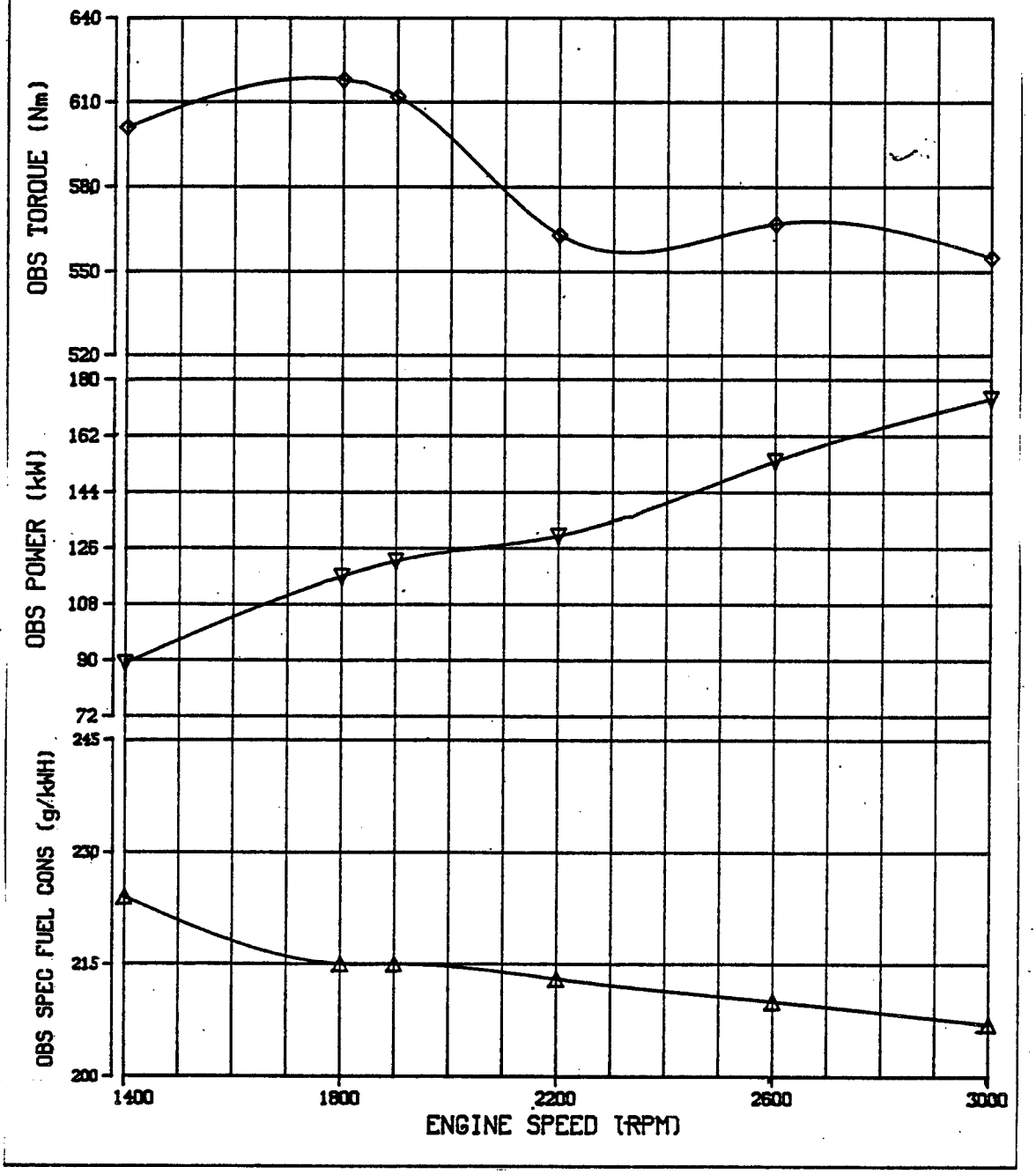
TABLE 4. Code E-430 Engine Full-Load Performance Data
Before Endurance - 300 Hours

SPEED (RPM)	OBSERVED TORQUE LB-FT (N-m.)	OBSERVED POWER BHP (kW)	OBSERVED FUEL FLOW LB/HR (KG/HR)	OBSERVED SPECIFIC FUEL CONSUMPTION LB/BHP-HR (g/kWH)	OIL SUMP TEMP °F (°C)	AIR CLEANER OUTLET TEMP °F (°C)	FUEL TEMP TO ENGINE °F (°C)	ENGINE COOLANT OUTLET TEMP °F (°C)
3,000	413	236.3	82.7	0.350	263.8	91.7	83.4	204.2
	(560)	(176.2)	(37.5)	(213)	(128.8)	(33.2)	(28.6)	(95.7)
2,600	420	209.4	74.5	0.355	255.1	92.1	85.4	204.6
	(570)	(156.2)	(33.8)	(216)	(123.9)	(33.4)	(29.7)	(95.9)
2,200	420	175.9	62.8	0.356	247.8	90.8	85.2	204.3
	(570)	(131.2)	(28.5)	(217)	(119.9)	(32.7)	(29.6)	(95.7)
1,900	460	166.2	59.5	0.357	245.6	90.2	84.3	204.5
	(624)	(123.9)	(27.0)	(217)	(118.7)	(32.3)	(29.1)	(95.8
1,800	466	159.0	57.1	0.359	241.1	89.7	83.9	205.5
	(623)	(118.5)	(25.9)	(218)	(116.2)	(32.1)	(28.8)	(96.4)
1,400	447	120.2	43.9	0.365	229.0	89.1	84.2	203.5
	(606)	(89.6)	(19.9)	(222)	(109.4)	(31.7)	(29.0)	(95.3)

Applicable Test Conditions/Range Variations

Intake Air Restriction 1.6 to 5.6 in. H_2O (4.0 to 13.9 mbar)
Exhaust Gas Outlet Pressure 3.8 to 13.3 in. H_2O (9.4 to 33.1 mbar)
Dry Air Barometer: 29.70 in. Hg (1,005.6 mbar)

FIGURE- 9
FULL LOAD PERFORMANCE (400 HOURS)



FIGURE–10
FULL LOAD PERFORMANCE (400 HOURS)

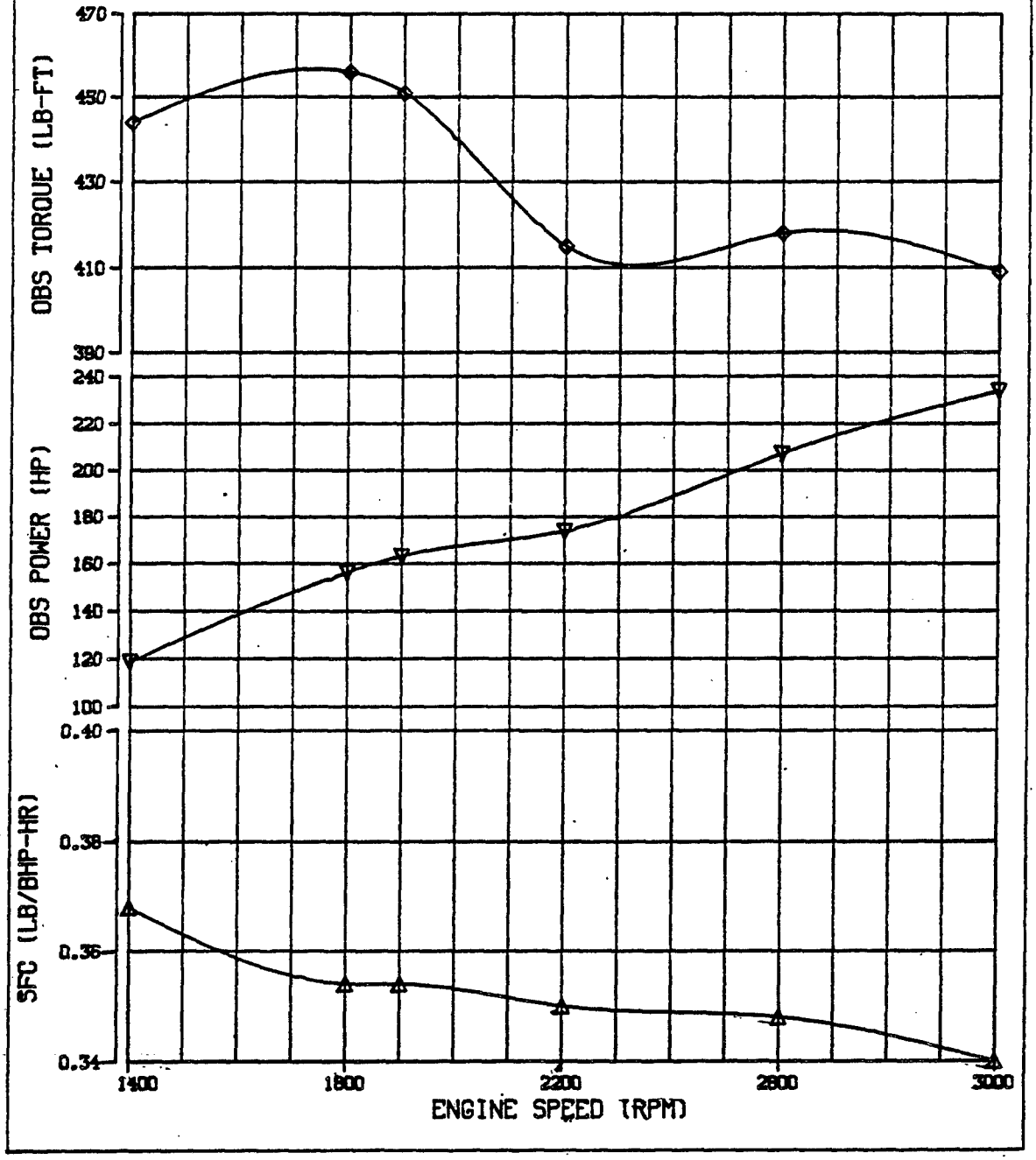


TABLE 5. Code E-430 Engine Full-Load Performance Data
Before Endurance - 400 Hours

SPEED (RPM)	OBSERVED TORQUE LB-FT (N-m.)	OBSERVED POWER BHP (kW)	OBSERVED FUEL FLOW LB/HR (KG/HR)	OBSERVED SPECIFIC FUEL CONSUMPTION LB/BHP-HR (g/kWH)	OIL SUMP TEMP °F (°C)	AIR CLEANER OUTLET TEMP °F (°C)	FUEL TEMP TO ENGINE °F (°C)	ENGINE COOLANT OUTLET TEMP °F (°C)
3,000	409.1	233.8	79.4	0.340	261.4	79.8	84.8	206.1
	(555)	(174.3)	(36.0)	(207)	(127.4)	(26.6)	(29.3)	(96.7)
2,600	418.4	207.1	72.1	0.348	250.6	79.0	85.4	205.8
	(567)	(154.4)	(32.7)	(210)	(121.4)	(26.1)	(29.7)	(96.6)
2,200	414.9	173.9	60.9	0.350	244.7	78.1	83.9	205.7
	(563)	(129.7)	(27.6)	(213)	(118.2)	(25.6)	(28.8)	(96.5)
1,900	451.2	163.2	57.9	0.354	242.3	76.3	84.4	206.3
	(612)	(121.7)	(26.3)	(215)	(116.8)	(24.6)	(29.1)	(96.8)
1,800	455.7	156.3	55.4	0.354	240.2	76.2	85.2	206.5
	(618)	(116.6)	(25.1)	(215)	(115.7)	(24.6)	(29.6)	(96.9)
1,400	443.5	118.8	43.8	0.368	231.8	79.0	85.4	205.0
	(601)	(88.6)	(19.9)	(224)	(111.0)	(26.1)	(29.7)	(96.1)

Applicable Test Conditions/Range Variations

Intake Air Restriction 1.6 to 5.1 in. H_2O (4.0 to 12.7 mbar)
Exhaust Gas Outlet Pressure 1.3 to 16.2 in. H_2O (3.2 to 40.3 mbar)
Dry Air Barometer: 29.55 in. Hg (1,000.6 mbar)

TABLE 6. Oil Consumption During Endurance Test

Engine Test Hours	Quantity Oil Added (lb)	Cumulative Consumption (lb)
0	0	SUMP FULL
16	.998	.998
22.3	.798	1.79
30	.899	2.69
44	.798	3.49
50.5	.299	3.79
56	1.19	4.99
67.5	.599	5.59
74	.198	5.79
80.5	1.19	6.99
94	.599	7.59
100	0	7.59
117.5	1.09	8.68
124	1.19	9.88
145.5	1.29	11.18
174	1.80	12.98
193	1.99	14.98
200	0	14.98
216	1.09	16.08
223	1.19	17.28
236	1.19	18.48
257	2.79	21.28
277.5	1.79	23.08
290.5	.998	24.07
300	0	24.07
317	1.49	25.57
327.5	.998	26.57
339.5	.998	27.57
350.5	1.74	29.32
374	1.49	30.82
386	1.89	32.72
397.5	1.19	33.92
400	0	33.92

FIGURE- //
FULL LOAD HEAT REJECTION

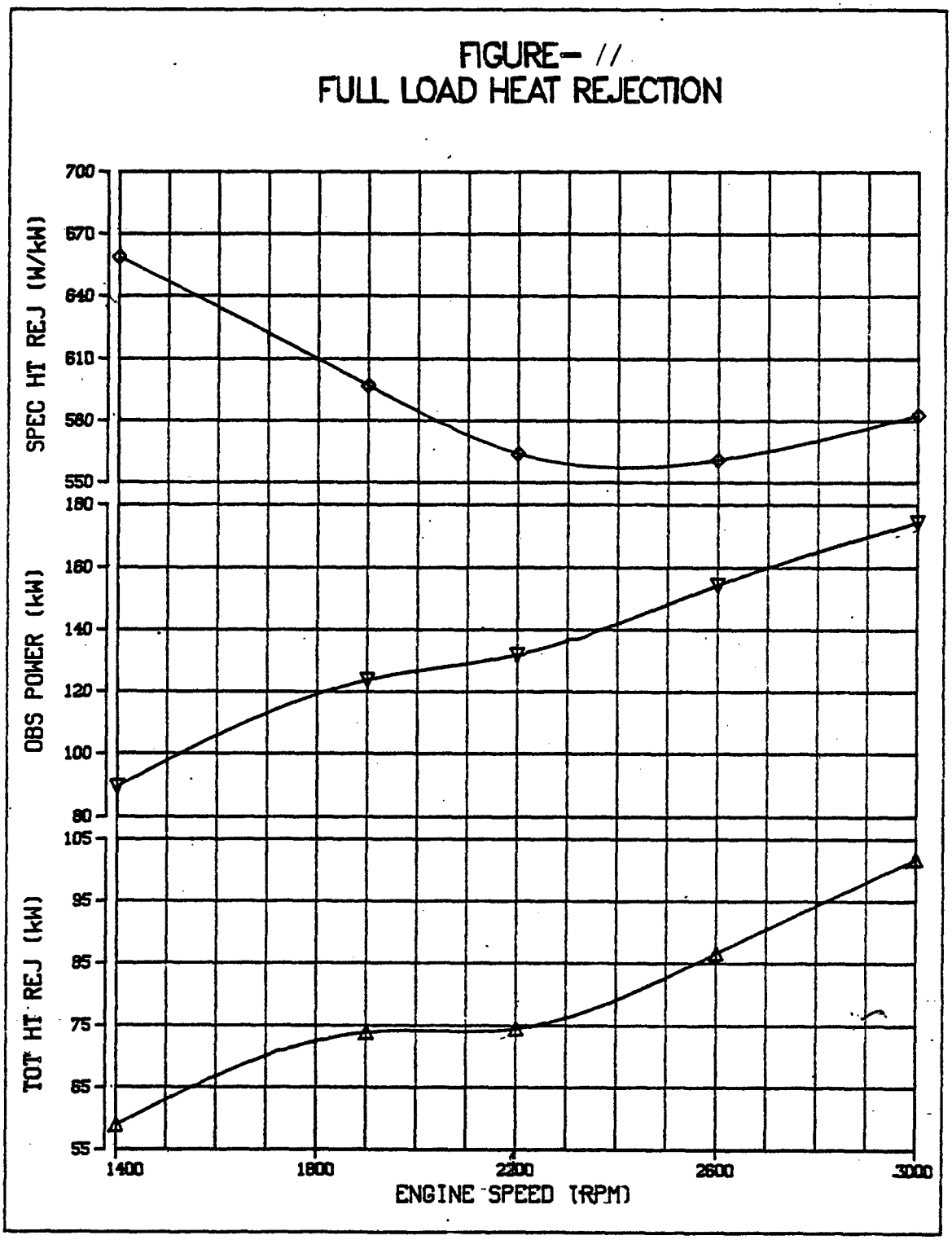


FIGURE- 12
FULL LOAD HEAT REJECTION

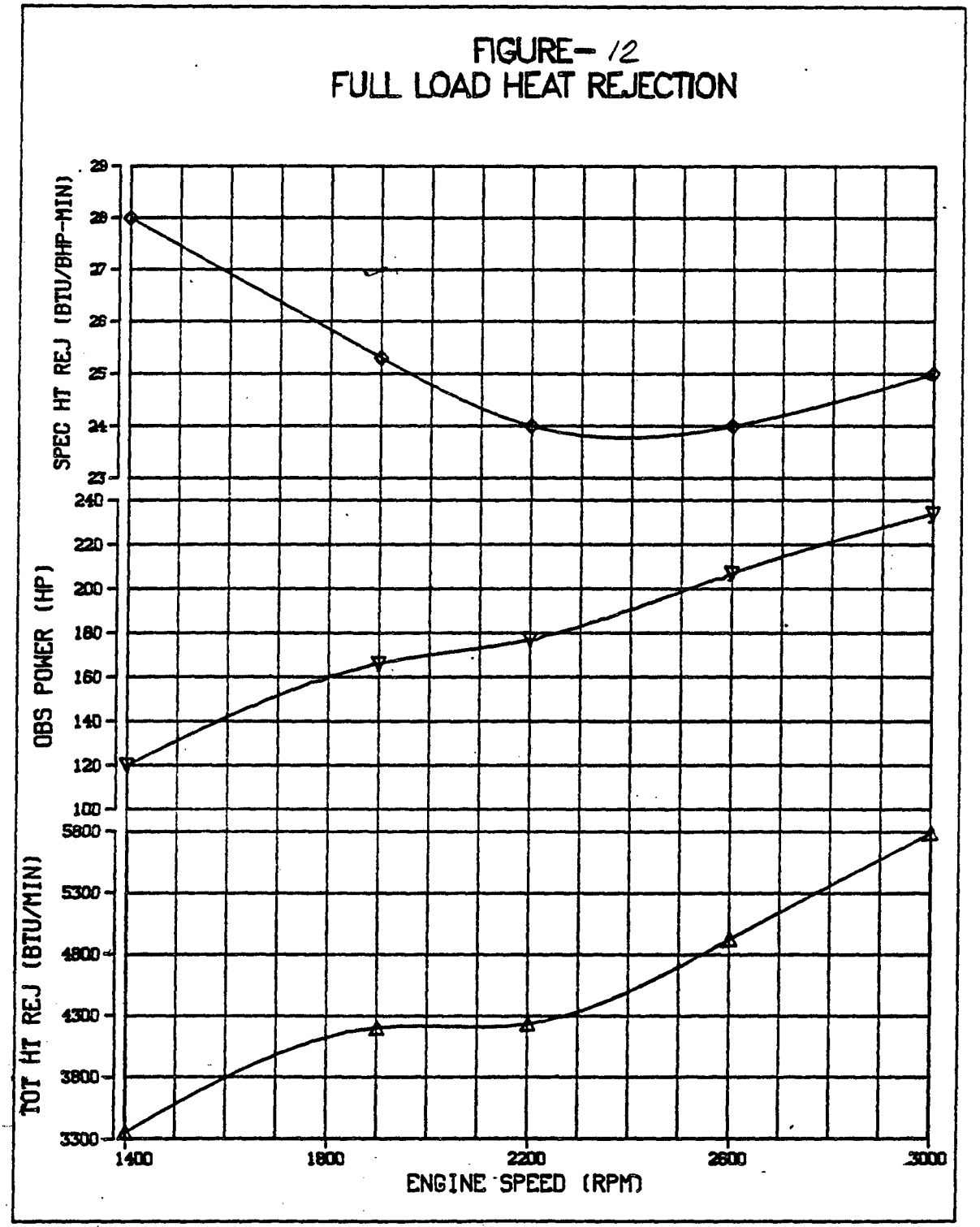


TABLE 7. Bosch Smoke Readings

RPM	100 HR
1,400	2.40
1,600	
1,800	0.90
1,900	0.90
2,000	
2,200	0.60
2,400	
2,600	0.60
2,800	
3,000	0.60

RPM	200 HR
1,400	2.60
1,600	
1,800	0.60
1,900	0.90
2,000	
2,200	0.10
2,400	
2,600	0.05
2,800	
3,000	0.05

RPM	300 HR
1,400	1.75
1,600	
1,800	0.09
1,900	0.70
2,000	
2,200	0.40
2,400	
2,600	0.10
2,800	
3,000	0.75

RPM	400 HR
1,400	2.4
1,600	1.0
1,800	0.55
1,900	0.15
2,000	0.40
2,200	0.20
2,400	0.05

TABLE 7. (CONT'D) Bosch Smoke Readings

2,600	0.05
2,800	0.05
3,000	0.05

TABLE 8. Crankcase Pressure During Endurance

(Inches of Water)

ENDURANCE HOURS	3,000 RPM FULL-LOAD		1,800 RPM FULL-LOAD	
	H.P.	CRANKCASE PRES.	H.P.	CRANKCASE PRES.
10	226	9.8	153	3.8
20	228	10.0	153	4.0
30	228	10.6	154	4.0
40	232	11.6	155	4.3
50	228	10.7	155	4.5
60	231	13.5	156	5.3
70	232	13.6	156	5.0
80	231	14.0	157	5.4
90	230	13.8	157	5.4
100	231	14.5	157	5.7
110	232	15.6	157	5.8
120	232	15.8	156	6.4
130	232	15.4	156	5.8
140	233	14.5	157	5.9
150	234	15.5	157	6.3
160	234	15.5	158	5.4
170	234	16	158	5.9
180	234	15.8	157	6.5
190	234	15.9	157	6.1
200	235	17.9	159	6.1
210	234	17.3	158	6.1
220	234	17.9	157	6.6
230	233	17.3	157	5.8
240	233	16.8	158	6.8

TABLE 8. (CONT'D) Crankcase Pressure During Endurance

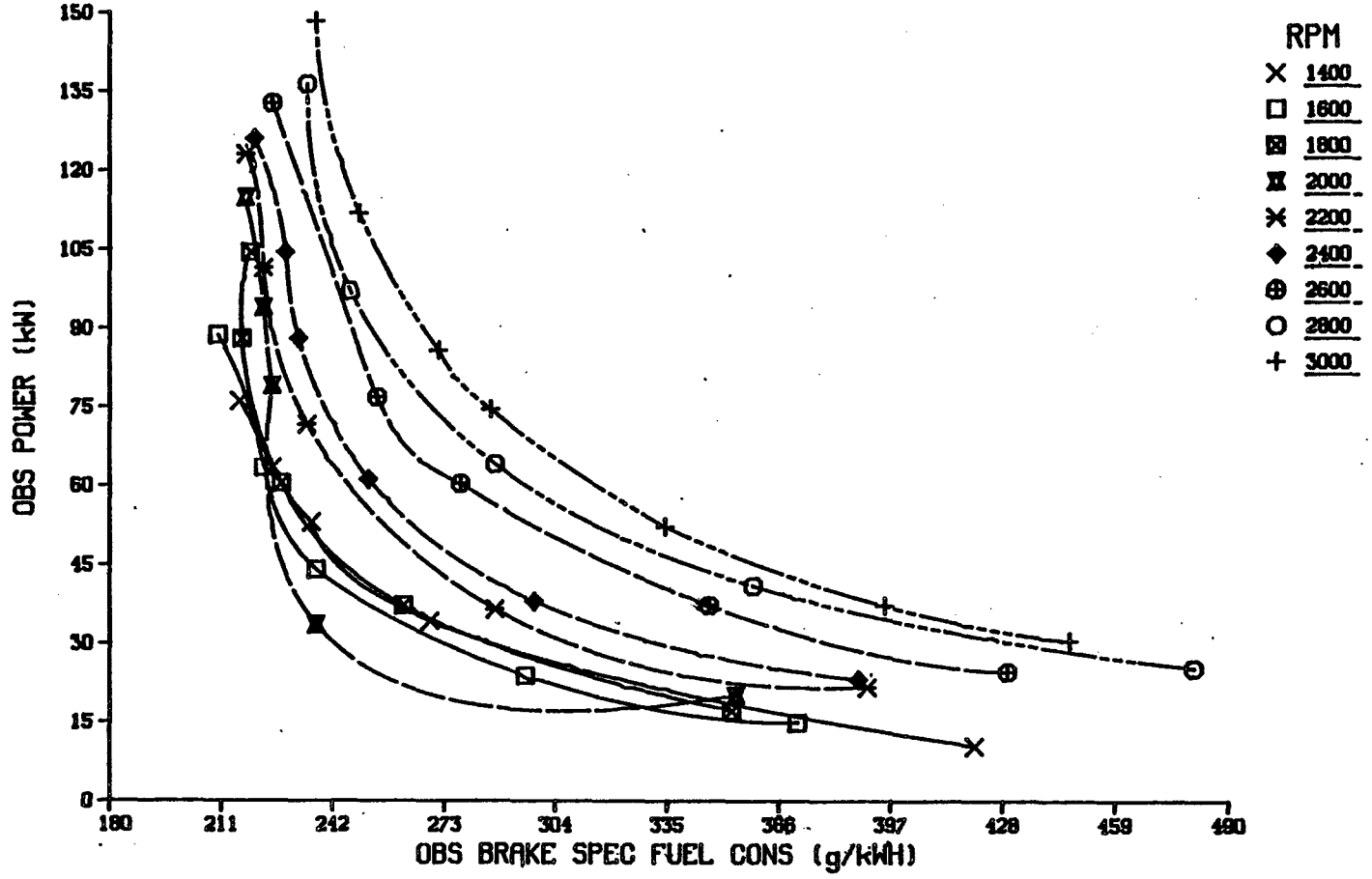
(Inches of Water)

ENDURANCE HOURS	3,000 RPM FULL-LOAD		1,800 RPM FULL-LOAD	
	H.P.	CRANKCASE PRES.	H.P.	CRANKCASE PRES.
250	233	17	157	5.8
260	235	17	157	6.6
270	235	17.8	156	6.1
280	232	17.5	156	6.2
290	235	16	157	5.8
300	236	16.1	159	6.2
310	234	17.3	156	5.5
320	234	16.4	157	6.3
330	233	16.5	159	6.1
340	235	17.2	157	5.4
350	234	17.2	157	5.4
360	233	16.3	157	5.9
370	235	16.4	157	6.0
380	233	17.4	156	6.2
390	232	17	158	6.4
400	234	17.4	156	6.0

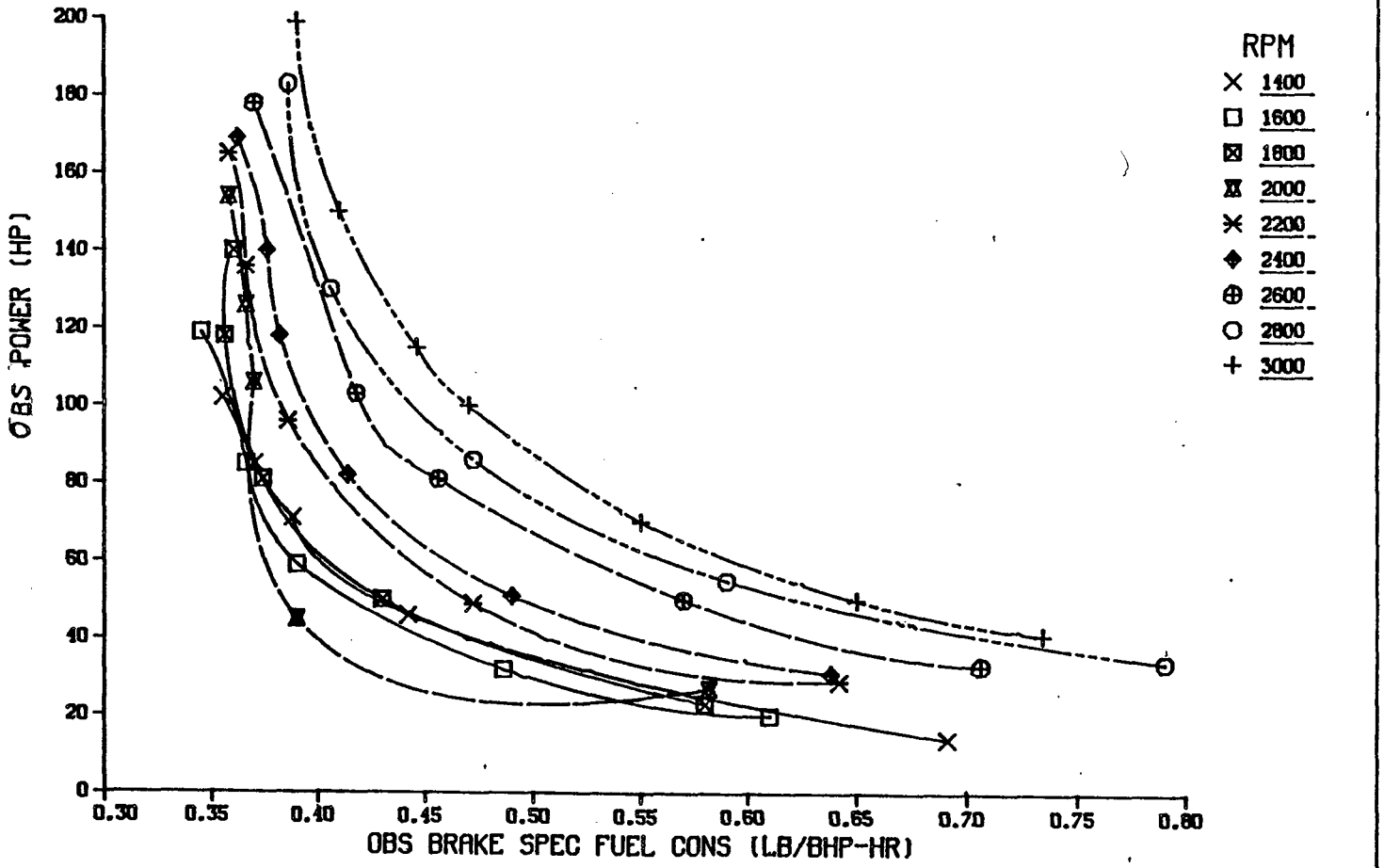
NOTE:

Crankcase pressure fluctuated and was read through a .302 inch diameter escape orifice using a water manometer.

FIGURE– 13
PART LOAD PERFORMANCE
BEFORE ENDURANCE



FIGURE– 14
PART LOAD PERFORMANCE
BEFORE ENDURANCE



APPENDIX A - TEST PROGRAM

PROPULSION SYSTEMS DIVISION

Test Program E-430 Diesel Engine
(Cell 6)

TITLE: MACI Evaluation of the Code E-430 Engine

PURPOSE:

To determine the military adaptability and performance characteristics of Code E-430 Commercial Diesel Engine.

OUTLINE OF TESTS:

1./ Prepare Code E-430 engine for performance and endurance tests.

2./ Install instrumentation.

3./ Calibration of instrumentation and equipment.

4./ Engine operating limits, adjustments and instrumentation checkout.

5./ Engine instrumentation and full-load operational checkout.

6./ Full-load performance.

7./ Part-load performance.

8./ Full-load heat rejection. (At completion of durability test.)

9./ Four-hundred-hour NATO endurance test.

10./ Disassembly and visual inspection of engine.

11./ Evaluation of results and final report.

TEST MATERIAL:

1./ Engine Code E-430	235 HP @ 3000 RPM, 450 lb-ft @ 2200 RPM Governed speed
Type	V
Number of cylinders	8
Bore and stroke, -in.	4.625 and 3.75
Displacement - cu-in	504
Method of operation	
Compression ratio	16.0:1

2./ Lubricating oil - Referee, grade 30, conforming to Military Specification MIL-L-2104C. (Imperial Oil Company)

Fuel - Federal Specification MIL-F-46162B (high sulfur)

TEST EQUIPMENT:

Test Cell No. 6, dynamometer, controls, associated instrumentation and equipment, Bldg. 212.

TEST PROCEDURES:

1./ Prepare engine for performance tests.

a./ Obtain dry weight of engine and record. Install engine in test cell and make connections to dynamometer. Make necessary fuel, exhaust, and intake air connections. Install cooling tower and fuel throttle and shut-down connections. Make provisions for taking smoke readings and measuring air flow.

b./ Install all required thermocouples, pressure lines, speed and load cell connections. Install warning light, shutdown system for critical temperature, pressure and RPM limits on engine and dynamometer equipment.

c./ Cooling tower will utilize a sight glass in the lower pipe (engine inlet) filled with water and antifreeze. A 10-15 PSI pressure cap will be used and shop air, through a regulator, will supply approximately 7 PSI pressure to the cooling system.

d./ During heat rejection tests, an engine thermostat (180°) will be used. The cooling tower will be adjusted to maintain 205°F ±2° engine out temperature. (Do not let oil temp exceed limits).

e./ Engine blowby and/or crankcase will be closely monitored during full power performance run to check proper engine operation. In addition, engine oil temperature and pressure will be closely monitored.

2./ Instrumentation - Install instrumentation to obtain and record data at each specified speed.

a./ Temperature, F	Range in °F	Accuracy in °F
(1) Air, cell ambient	60-120	± 2
(2) Air cleaner, inlet	60-120	± 2
(3) Air cleaner, outlet	60-120	± 2
(4) Air, Entrance to Air Meter	60-120	± 2
(5) Air, Turbo Outlet	120-500	± 2

Temperature, F		Range in °F	Accuracy in °F
(6)	Exhaust, After Turbo	200-1500	±10
(7)	Exhaust, Ports (8)	200-1500	±10
(8)	Oil Sump	60-300	±2
(9)	Fuel, Before Secondary Filter	60-120	±2
(10)	Coolant, Engine Inlet **	120-250	±2
(11)	Coolant, Engine Outlet **	120-250	±2
(12)	Cooling Water, Tower Inlet *	35-100	-
(13)	Cooling Water, Tower Outlet *	35-250	-
(14)	Engine Oil Gallery	60-300	±2
(15)	Instrumention Bath	200	±1
(16)	Fuel Spill	60-160	±2

** Indicates Quartz Temperature Probes in addition to regular thermocouple
* Indicates Quartz Temperature Probes

b./ Pressures, Gauge		Range	Accuracy
(1)	Air, Test Cell In. H_2O	0 to -1	±1
(2)	Air, After Air Cleaner(In. H_2O)	0 to -25	±1
(3)	Air, Across Air Meter Entrance (In. H_2O)	0 to -20	±1
(4)	Air at Air Meter Center	0 to -20	±.01
(5)	Air at Turbo Entrance (In. H_2O)	0 to -30	±1
(6)	Air, Crankcase (In. H_2O)	0 to +10	±1
(7)	Exhaust Outlet In. H_2O	0 to 60	±1
(8)	Fuel Supply (At Secondary Filter) PSI	0 to 10	±.5
(9)	Fuel Rail PSI	0 to 280	±2
(10)	Engine Oil Gallery (Manifold) PSI	0 to +100	±2

Pressures, Gauge	Range	Accuracy
(11) Coolant Pump Outlet PSI	0 to +50	±2
(12) Coolant Pump Inlet PSI	0 to ±25	±1

c./ Miscellaneous

(1) Engine speed, (RPM)	0 - 4000	±10 RPM
(2) Dynamometer load, (ft-lb)	600	±1%
(3) Fuel flow (lb/hr)	0 - 125	±1%
(4) Blowby (CFM)	0 - 10	±.2
(5) Air Flow	-	-

d./ Special Instruction Considerations

(1) Dymec data acquisition system to be used for data gathering.

(2) Quartz Ther mometers to be used for heat rejection test.

(3) Load cell to be used for measuring torque.

(4) Digital Cox fuel weigh system to be used for measuring fuel.

(5) Cooling water weigh system 0-250, lbs.

(6) Smoke density, Bosch system.

(7) Blowby meter for measuring engine blowby.

(8) Meriam air flow meter.

(9) Temperature reference bath (Maintain at 200° F).

3./ Calibration of instrumentation and equipment.

All instrumentation and equipment will be calibrated prior to start of test and at ranges specified in the previous paragraph 2.

4./ Engine operating limits and adjustments.

a./ Observe the following engine operating limits and test conditions for performance and endurance tests.

(1) Oil Gallery Temperature : 250° F warning, 260° F manual return to idle and contact test engineer.

(2) Oil pressure at idle: 15 PSI warning, 10 PSI shutdown. Oil pressure at normal operation: 40 to 75 PSI above 1000 RPM, 30 PSI warning, 25 PSI shutdown.

(3) Air cell ambient as close as possible to 77°F.

(4) Coolant outlet temperature 205 ± 5°F, warning 210°F, manual return to idle at 215°F. Cooling system will be pressurized to 7 PSI.

(5) Fuel temperature before pump: 85°F ± 5°F.

(6) Exhaust outlet pressure at rated conditions: 16 in. H_2O ± 3.

(7) Crankcase pressure maximum 5 in. H_2O. Blowby maximum 6 CFM.

(8) Nominal fuel flow 90 lb/hr at 3000 RPM.

(9) Exhaust port outlet temperature 1300°F maximum.

b./ Maintain and record the following adjustments at completion of each 100 hour interval of endurance test.

(1) Idle speed 650 RPM

(2) Governed speed 3400 RPM

(3) No load speed

Speeds will be verified after break in.

5./ Engine Run-In and Instrumentation Checkout.

a./ Engine will be run to check leaks, instrumentation, recording and printout systems. The following temperatures and pressures will be maintained:

(1) Ambient air (maintain as close as possible to 77°F)

(2) Inlet air (maintain as close as possible at 77°F)

(3) Air pressure at engine inlet at rated conditions, -5 ± 1 in. H_2O.

(4) Exhaust pressure outlet at rated conditions, 16 ± 3 in. H_2O.

(5) Coolant outlet temperature 205°F ± 5°F.

(6) Fuel temperature before pump 85°F + 5°F.

b./ Full-load operational check will be conducted according to the following schedule. During break-in monitor blowby in CFM and/or pressure. Do not continue test if blow-by exceeds allowed maximum. For each break-in period take complete data and record on log sheet. All conditions as above.

BREAK-IN SCHEDULE

TIME IN MINUTES	ENGINE SPEED RPM	TORQUE LB-FT	H.P.
20	650 (Idle)	0	0
20	1200	46	(10.6)
20	1400	94	(25)
20	1600	99	(30)
20	1800	117	(40)
20	1900	138	(50)
20	2000	158	(60)
20	2200	215	(90)
20	2400	263	(120)
20	2600	323	(160)
15	2800	375	(200)
10	3000	420 + Full Rack	(240)
10	2600	323	(160)
10	1900	455 + Full Rack	(180)
10	1200	46	(10.6)
10	650	0	0

c./ Check governor for full- and no-load speeds and notify test engineer prior to making adjustments.

6./ Performance Test (Nominal 235 BHP)

Conduct performance tests with full rack, under the conditions listed in paragraph 4. Record all data listed under instrumentation for engine speeds of 1400 RPM to 3000 RPM in 200 RPM decrements with a reading also at peak torque - 1900 RPM. At each setting the engine should be run for a sufficient time for stabilization. Part-load performance will be conducted following this performance test and at completion of durability test. Heat rejection test will be conducted at completion of the durability test.

7./ Part-Load Performance Test (Nominal 235 BHP)

Conduct part load performance tests at 85, 70, 60, 50, 40, 25 and 15 percent loads using speeds from 1400 RPM to 3000 RPM in 200 increments (also 1900 RPM). Paragraph #5 conditions will be maintained during runs. Perform an idle fuel consumption test run with complete printout at the end of part load performance tests.

8./ Heat Rejection Tests (Perform at Completion of Durability Test)

Determine heat rejection at full load, 205° ± 2°F, engine coolant out temperature at the following speeds: 3000 RPM to 1400 RPM in 400 RPM decrements. Remaining conditions as specified in paragraph #4. (Engine operating limits and adjustments.).

9./ Four Hundred (400) Hour NATO Endurance Test

a./ The 400 hour NATO endurance test will be divided into four periods of 100 hours each. Each 100-hour period is to consist of ten (10)-hour periods as shown in test schedule A. (New NATO cycle).

TEST SCHEDULE A

Period	Percent Rated Speed	Percent Load	Time Hours
1	Idle (650 RPM)	0	½
2	100 (3000 RPM)	100	2
3	Governed Speed	0	½
4	75 (2250 RPM)	100	1
5	Idle ↔ 100	0 ↔ 100 4 min. 6 min.	2
6	60 (1800 RPM)	100	½
7	Idle	0	½
8	Governed Speed	70	½
9	Max. Torque Speed (1900 RPM)	100	2
10	60 (1800 RPM)	50	½
		TOTAL DURATION	10

Conduct 400-hour NATO endurance test according to Test Schedule A. Values of speeds and torque to be provided by test engineer following completion of performance test.

b./ During 400-hour endurance test, the following pressures and temperatures will be regulated to the values as indicated.

(1) Pressures

a./ Air pressure after the air cleaner shall be -5 ± 1 in. H_2O at rated conditions.

b./ Exhaust outlet pressure at rated conditions through speed range 16 ± 3 inches H_2O, restriction held at other speeds.

(2) Temperatures

a./ Ambient air as close as possible to $77^{\circ}F$

b./ Inlet air as close as possible to $77^{\circ}F$

c./ Coolant outlet temperature $205^{\circ}F \pm 5^{\circ}F$

d./ Fuel before diaphragm pump $85^{\circ}F \pm 5^{\circ}F$

c./ Take eight-ounce oil sample before starting endurance and every 100 hours thereafter, take two ounces oil sample at 25-hour intervals. (Purge oil sample line and take sample from oil gallery with engine idling. Replace the removed sample oil with same amount and type new one.

d./ Check engine oil level and appearance at completion of every shift and before engine is started for a new day of tests.

e./ Data will be recorded during the last five minutes of each of the ten periods listed in Test Schedule A; and just before stopping engine.

f./ The following maintenance and adjustments to engine will be conducted after each 100-hour test period and before power check:

(1) Change oil

(2) Replace oil and fuel filters

(3) Record oil added (less sample) to bring to required level

(4) Maintain adjustments as indicated on pages A-5 and A-6.

(5) Inspect engine for leaks, breaks, noise, vibration, etc.

g./ The 100-hour power check tests shall be conducted under temperature and pressure conditions listed. Record all data listed under "Instrumentation" for engine speeds from 1400 RPM to 3000 RPM in 200-RPM decrements, up and down and at idle speed and 1900 RPM. At each setting, the engine should be run for a sufficient time for stabilization. In addition, smoke density samples will be taken at each speed setting.

10./ Obtain photographs of engine test set up.

Disassembly and Inspection of Engine. Record breaking torques - and photograph parts if required during disassembly.

11./ Evaluation of Results and Report.,

a. Consolidate and evaluate data.

b. Prepare report.

c. Obtain photographs of engine wear surfaces.

JOB ASSIGNMENTS:

1. DRSTA-TB will be responsible for gathering data, maintaining a daily log book and test data log, directing personnel and general execution of test.

2. DRSTA-RGES will be responsible for day to day technical decisions, monitoring test, evaluation of data and preparing a report.

3. Any changes in the above test program shall be mutually agreed upon by DRSTA-TB and DRSTA-RGES and confirmed by a supplement to this basic test program. Each supplement will be evaluated for potential cost and for schedule revisions.

Written By:

Roy J. G. Rimpela
Project/Test Engineer

Reviewed and Approved By:

Gene G. Engel
C, MACI and Special Projects

APPENDIX B - FUEL ANALYSIS

ANALYSES OF REFEREE GRADE DIESEL FUEL
(MIL-F-46162B) SAMPLES

Properties	Requirements	#6 Tank AL-12077-F
Density, kg/L at 15°C	Report	0.8655
Gravity, °API	NR (1)	31.9
Distillation, °F (°C)		
Initial boiling point	Report	380 (193)
10% recovered	Report	446 (230)
50% recovered	473-545 (245-285)	514 (268)
90% recovered	626-675 (330-357)	616 (324)
95% recovered	662-707 (350-375)	646 (341)
End point, max	725 (385) max	678 (359)
Sulfur, wt%	0.95-1.05	1.05
Accelerated stability,		
total insolubles, mg/100 mL	1.5 max	1.4
Cetane number	40-45	54
Cetane index	40-45	42
Kinematic viscosity at		
40°C, cSt	1.9-4.1	—
Cloud point, °C	-13 max	—
Particulate contamination,		
mg/L (0.8μm filter)	10 max	2.5
Volume filtered, L	1	1

(1) NR = No requirement
(2) -- = Not measured

APPENDIX C - SAMPLE DATA SHEET

430 TAPE
TEST CELL NO 6
OBJECT OF TEST 300 HOUR POWER CURVE

U.S. ARMY TANK AUTOMOTIVE COMMAND
RESEARCH AND DEVELOPEMENT CENTER
ENGINE CODE NO. E 430 ENGINE SERIAL NO. 20227520
FUEL MIL-F-46162B (SULPHUR) OIL MIL-L-2104C (IMPERIAL OIL)

PAGE NO. 85
TEST ENGINEER R. RIMPELA
TEST OBSERVER MASTY
SCHIELE

DATE 15 JULY, 1982 START SLOW STOP
TIME 1230 1415 1430
READING NO
TOTAL TEST HOURS 3008.00
TOTAL ENGINE HOURS 404 15

				1200				
OBSERVED BAROMETER	HG			29.70				
TEMP CORRECTION	HG			.14				
CORRECTED BAROMETER	HG			29.56				
VAPOR PRESSURE	HG			.68				
DRY AIR BAROMETER	HG			28.88				
WET BULB TEMP	F			72				
DRY BULB TEMP	F			82				
		FR	FR	FR	FR	FR	FR	
INDICATED ENGINE RPM		1400	1800	1900	2200	2600	3000	
ACTUAL ENGINE RPM		1404	1803	1902	2201	2601	3001	
DYNAMOMETER LOAD	Torque	447	466	460	420	420	413	lb-ft
OBSERVED HP	HP	120.24	159	166.2	176	205.4	236.3	HP
CORRECTED HP								
OBSERVED TORQUE	Metric Torque	606.1	631.9	632.8	569.5	569.6	560.03	N-M
CORRECTED TORQUE	HP	89.6	118.5	123.9	131.2	156.1	176.2	KW
FUEL WEIGHT INC		1.0	1.0	1 0	1.0	1 0	1.0	
TIME IN SEC		82 00 81.92	63 04 63.07	60.58 60.55	57.38 57.32	48.46 48.43	43.48 43.54	
TIME IN SEC		81.84	63,11	60,51	57.26	48.19	43.60	
CAL FUEL CONS LBS PER HOUR		43.9	57.08	59.45	62.8	74.5	82.68	
FUEL CONS LBS BHP HOUR.		.365	.359	.357	.356	.355	.35	
TOTAL FUEL CONS GALLONS	metric BSFC	222.1	218.4	217.2	216.5	215.9	212.9	g/Kw-H
ENGINE OIL ADDED		00						
REFERENCE BATH TEMP		200 0	200.0	200.0	200 0	200.0	199 8	
CRANKCASE MONOMETER IN H20		4.4	6.2	7.0	7 4	11.0	16.11	
QUARTZ T1 WATER TOWER INLET								
QUARTZ T2 WATER TOWER OUTLET								
QUARTZ T1 T2 DIFF								
QUARTZ T1 ENGINE COOLANT IN								
QUARTZ T2 ENGINE COOLANT OUT								
QUARTZ T1 T2 DIFF								
BOSCH SMOKE READING		X						

Avg Exhaust Gas Temp (°F) 995.5° @ 1800 rpm C-2
955.6 @ 3000 rpm

	t 125901	t 131052	t 132110	t 134051	t 135309	t 140640
010 ENGINE RPM	r 010 + 001409 0	r 010 + 001805 0	r 010 + 001903 0	r 010 + 002200 0	r 010 + 002601 0	r 010 + 003002 0
020 DYNAMOMETER LOAD	w 020 + 004482 1	w 020 + 004626 1	w 020 + 004586 1	w 020 + 004202 1	w 020 + 004229 1	w 020 + 004134 1
031 CELL AIR TEMP RIGHT	j 031 + 009280 2	j 031 + 009612 2	j 031 + 009687 2	j 031 + 009793 2	j 031 + 010040 2	j 031 + 009961 2
032 CELL AIR TEMP LEFT	j 032 + 008963 2	j 032 + 009000 2	j 032 + 009069 2	j 032 009212 2	j 032 + 009274 2	j 032 + 009278 2
033 AIR INTAKE MANIFOLD	j 033 + 013795 2	j 033 + 016301 2	j 033 + 016947 2	j 33 + 018028 2	j 033 + 021125 2	j 033 + 024468 2
034 AIR CLEANER INLET	j 034 + 008918 2	j 034 + 008965 2	j 034 + 008994 2	j 034 + 009121 2	j 034 + 009176 2	j 034 + 009181 2
035 AIR TURBO INLET	j 035 + 008914 2	j 035 + 008970 2	j 035 + 009017 2	035 + 009078 2	j 035 + 009208 2	j 035 + 009174 2
036 OIL SUMP	j 036 + 022901 2	j 036 + 024111 2	j 036 + 024559 2	j 036 + 024778 2	j 036 + 025514 2	j 036 + 026384 2
037 FUEL B4 SEC FILTER	j 037 + 008423 2	j 037 + 008387 2	j 037 + 008428 2	j 037 + 008517 2	j 037 + 008544 2	j 037 + 008341 2
038 COOLANT ENGINE INLET	j 038 + 018916 2	j 038 + 019228 2	j 038 + 019036 2	j 038 + 019197 2	j 038 + 01922 2	j 038 + 019192 2
039 COOLANT ENGINE OUTLET	j 039 + 020345 2	j 039 + 020554 2	j 039 + 020454 2	j 039 + 020432 2	j 039 + 020459 2	j 039 + 020424 2
040 COOLANT WATER TOWER IN	j 040 + 008398 2	j 040 + 008480 2	j 040 + 008524 2	j 040 + 008569 2	j 040 + 008611 2	j 040 + 008639 2
041 COOLANT WATER TOWER OUT	j 041 + 019275 2	j 041 + 019526 2	j 041 + 019465 2	j 041 + 019529 2	j 041 + 019525 2	j 041 + 019416 2
042 OIL ENGINE GALLERY	j 042 + 021983 2	j 042 + 023018 2	j 042 + 023352 2	j 042 + 023556 2	j 042 + 024188 2	j 042 + 024852 2
043 REFERENCE BATH	j 043 + 020115 2	j 043 + 020019 2	j 043 + 020062 2	j 04 + 020076 2	j 043 + 020070 2	j 043 + 020016 2
044 FUEL SPILLBACK	j 044 + 015592 2	j 044 + 015453 2	j 044 + 015505 2	j 044 + 000 2	j 044 + 015559 2	j 044 + 015337 2
045 DYNA WATER TEMP	j 045 + 011150 2	j 045 + 011646 2	j 045 + 011764 2	045 + 01876 2	j 045 + 012135 2	j 045 + 012468 2
050 EXH PORT 1R	050 + 009672 1	k 050 + 009860 1	050 + 009926 1	050 + 009312 1	050 + 009350 1	k 050 + 009556 1
051 EXH PORT 2R	051 + 009148 1	k 051 + 009587 1	k 051 + 009588 1	051 + 009260 1	051 + 009528 1	k 051 + 009897 1
052 EXH PORT 3R	052 + 010085 1	k 052 + 010537 1	k 052 + 010525 1	052 + 009718 1	k 052 + 009574 1	k 052 + 009675 1
053 EXH PORT 4R	k 053 + 009565 1	k 053 + 009885 1	k 053 + 009878 1	k 053 + 009280 1	k 053 + 009278 1	k 053 + 009495 1
054 EXH PORT 1L	k 054 + 010074 1	k 054 + 010255 1	k 054 + 010120 1	k 054 + 009273 1	k 054 + 009208 1	k 054 + 009302 1
055 EXH PORT 2L	k 055 + 010096 1	k 055 + 010425 1	k 055 + 010280 1	k 055 + 009576 1	k 055 + 009478 1	k 055 + 009620 1
056 EXH PORT 3L	k 056 + 009539 1	k 056 + 009875 1	k 056 + 009880 1	k 056 + 009316 1	k 056 + 009323 1	k 056 + 009481 1
057 EXH PORT 4L	k 057 + 009482 1	k 057 + 009536 1	k 057 + 009515 1	k 057 + 009078 1	k 057 + 009194 1	k 057 + 009427 1
058 EXH B4 TURBO R	k 058 + 010475 1	k 058 + 010718 1	k 058 + 010660 1	k 058 + 010097 1	k 058 + 010172 1	k 058 + 010329 1
059 EXH B4 TURBO L	k 059 + 010329 1	k 059 + 010598 1	k 059 + 010511 1	k 059 + 009952 1	k 059 + 010010 1	k 059 + 010214 1
060 EXH AFTER TURBO	k 060 + 009106 1	k 060 + 009264 1	k 060 + 009253 1	k 060 + 008949 1	k 060 + 008857 1	k 060 + 008763 1
070 AIR TEST CELL PR	i 070 000399 3	i 070 000394 3	i 070 - 000377 3	i 070 - 000384 3	i 070 - 000389 3	i 070 - 000389 3
071 AIR AFTER CLEANER PR	i 071 - 000408 3	i 071 - 000404 3	i 071 - 000392 3	i 071 - 000386 3	i 071 - 000386 3	i 071 - 000386 3
072 AIR ACROSS AIR METER PR	i 072 - 000117 3	i 072 - 000108 3	i 072 - 000109 3	i 072 - 000104 3	i 072 - 000110 3	i 072 - 000114 3
073 AIR B4 TURBO PR	i 073 - 001590 3	i 073 - 002079 3	i 073 - 002435 3	i 073 - 003012 3	i 073 - 004177 3	i 073 - 005551 3
074 AIR INTAKE MANIFOLD PR	u 074 + 006758 3	u 074 + 010952 3	u 074 + 012112 3	u 074 + 014030 3	u 074 + 019417 3	u 074 + 024999 3
075 AIR CRANKCASE PR	i 075 + 006064 3	i 075 + 008919 3	i 075 + 010108 3	i 075 + 010778 3	i 075 + 015729 3	i 075 + 021713 3
076 EXH TURBO INLET L	u 076 + 003589 3	u 076 + 006406 3	u 076 + 007183 3	u 076 + 009362 3	u 076 + 014883 3	u 076 + 021987 3
077 EXH TURBO INLET R	u 077 + 006722 3	u 077 + 008910 3	u 077 + 009519 3	u 077 + 011226 3	u 077 + 015547 3	u 077 + 021042 3
078 EXH OUTLET	i 078 - 000376 3	i 078 + 001355 3	i 078 + 001984 3	i 078 + 002972 3	i 078 + 007600 3	i 078 + 013325 3
079 FUEL SUPPLY AT SEC FILTER	p 079 + 002488 3	p 079 + 001908 3	p 079 + 001836 3	p 079 + 001665 3	p 079 + 000900 3	p 079 + 000149 3
090 FUEL RAIL PR	p 090 + 006549 2	p 090 + 009156 2	p 090 + 009730 2	p 090 + 010349 2	p 090 + 014084 2	p 090 + 018316 2
091 OIL GALLERY PR	p 091 + 004415 2	p 091 + 005293 2	p 091 + 005398 2	p 091 + 006088 2	p 091 + 006485 2	p 091 + 006534 2
092 COOLANT PUMP OUT PR	p 092 + 001500 2	p 092 + 001604 2	p 092 + 001617 2	p 092 + 001742 2	p 092 + 001891 2	p 092 + 002092 2
093 COOLANT PUMP IN PR	p 093 + 015340 3	p 093 + 015138 3	p 093 + 015000 3	p 093 + 014893 3	p 093 + 014643 3	p 093 + 014432 3

APPENDIX D - NATO ENGINE TEST SPECIFICATIONS

NATO STANDARD ENGINE LABORATORY TEST

(GAS TURBINES ENGINES)

AEP-5

EDITION JUNE 80

CHAPTER 1

PURPOSE AND APPLICABILITY

SECTION 1-1. PURPOSE

The purpose of this document is to define a test method and standard conditions to enable all NATO countries to conduct tests using an identical method or to analyse the tests conducted in the laboratories of other NATO countries on the basis of this method.

The method described below is independent of existing national test methods, which may be used for supplementary testing.

When an engine has met the requirements of the tests under the present code, its power rating should be indicated as follows: "Power rating. . .Kw (. . .metric HP) at. . .RPM, in accordance with NATO code AEP 5. Edition June 1980."

SECTION 1-2 APPLICABILITY

These test conditions apply to all service vehicle (combat and transport) propulsion gas turbine engines with free power turbines.

NOTE : SI units will be used.

CHAPTER 2

TEST REQUIREMENTS

SECTION 2-1 - GENERAL COMPOSITION AND ORDER OF TEST

2.1.1. Engine reception.
Running-in in accordance with manufacturer's instructions.
Performance test, complete (full and part loads).
Endurance test.
Performance test, complete (full and part loads).
Disassembly, inspection and measurement.
Report.

NOTES : (1) Engine measurements may be carried out before running-in.

(2) The manufacturer is responsible for defining the running-in programme and the engine should have been run-in before it is submitted for testing.

(3) In so far as possible, the manufacturer's drawings and technical data will be supplied with the engine, to assist inspection and measurement of components.

(4) It is normal practice for the engine to be given a preliminary performance test immediately after receipt, to check acceptability.

(5) The initial, if accomplished, and final inspection of the engine should be carried out by the same inspection team using the same gauges.

2.1.2. During performance and durability testing, the following variables will be monitored :

a - Main values
Speed
Torque (engine output shaft)

b - Ambient conditions
Temperature of ambient air
Atmospheric pressure
Humidity

c - Air and gases
Inlet air temperature
Inlet depression
Inlet air flow (performance test only)
Exhaust temperature
Exhaust back pressure
Gas temperatures at points influencing fuel control (if required)

d - Lubrication and cooling
Oil temperatures and pressures
Temperatures into and out of external coolers
Flow rates of fluids to cooling devices external to the engine (for heat rejection calculations)
Oil consumption (during endurance tests only)

e - Fuel
Fuel temperature
Fuel consumption

f - Miscellaneous
Smoke density
Other parameters which influence fuel control
Vibration

2.1.3. Regulated parameters

Inlet Air Depression * at rated power :
$25 \pm 2{,}5$ mbar

Exhaust Back Pressure at rated power :
$20 \pm 2{,}5$ mbar

Fuel Temperature at Fuel Pump Inlet :
$30° C \pm 3° C$

Inlet Air Temperature :
See Section III

* Depression differential between static atmospheric air pressure and the total pressure at the point of measurement.

2.1.4. TEST CONDITIONS

Measuring is to be done in normal and stable operating conditions.

The temperature of the air entering the engine (ambient air) is to be measured at a maximum distance of 0,15 m from the air filter inlet or, if there is no filter, 0,15 m from the air inlet nozzle. The thermometer or thermocouple must be protected against heat radiation and be located directly in the air jet. Testing must be carried out in an adequate number of positions to give a representative inlet temperature.

Once an output speed has been selected for measurement purposes, its value must not vary by more than ± 1 % or ± 10 r.p.m. (whichever of these limits is the higher) during measurement.

The readings for brake load, fuel consumption and inlet air temperature are to be taken simultaneously, the value recorded being the average of two stabilized results, obtained in succession with brake load and fuel consumption differing by less than 2 %.

When a device fitted with an automatic starting system is used for measuring speed and fuel consumption, the duration of measurement must be at least 30 seconds ; if the measuring device is manually operated, the duration must be at least 60 seconds.

The exhaust gas outlet temperature must be measured at a point downstream and less than 100 mm from the flange (s) of the exhaust manifold (s).

Lubricant temperature is to be measured at the inlet and outlet of the heat exchanger if there is one. Otherwise it must be taken preferably in the lubrication system. The measuring point will be specified in the test report.

Fuel temperature must be read at the fuel pump inlet.

Auxiliary power take-offs may be loaded and measured if desired.

2.1.5. MEASUREMENT ACCURACY

- TORQUE

  The torque must be accurate within ± 0,5 % of the highest value recorded.

- OUTPUT SPEED

  Measurement must be accurate to within ± 0,5 %.

- FUEL CONSUMPTION

  ± 1 % for all apparatus used.

- TEMPERATURES

  Intake air ± 1°C.

- PRESSURE

  Atmospheric pressure ± 0,7 mbar
  Air and gas pressure ± 50 mbar
  Induction and exhaust pressure and depression ± 0,250 mbar
  Pressure of other fluids ± 250 mbar

SECTION 2-2 - DEFINITION OF ENGINE

Engines will be equipped only with such auxiliary equipment as is strictly essential to their operation (see table of auxiliary equipment at Annex A).

SECTION 2-3 - PERFORMANCE TEST

The performance test maximum load curve will be plotted from measurements taken at a minimum of five speed settings, one of these settings being the rated speed.

For each setting, the engine should be run for a sufficient time to allow the operating parameters to stabilize.

Part-load data is to be recorded at the same pre-selected speeds as was used for the full-load test. The part loads for each speed point are to be calculated at least for 85 %, 70 %, 50 % and 25 % of the full load at the given speed.

During this test, the smoke emission as measured on the Robert BOSCH Scale shall not exceed 4.5.

No correction factor will be applied and the test results must include air temperature and atmospheric pressure.

The inlet temperature shall be maintained as close as possible to 25°C.

SECTION 2-4 - ENDURANCE TEST

2.4.1. The endurance test duration is 400 hours, divided into four periods of 100 hours each. At the completion of each period, the engine shall be submitted to a full-load performance check.

During the endurance test, the inlet temperature will be kept as near as possible to 25° C or, when this is not practical, prevailing ambient.

2.4.2. Normal maintenance and adjustment will be permissible after each 100 hour test period.

2.4.3. Engine oil and filters may be changed after each 100 hour period.

2.4.4. The four 100 hour périods which make-up the endurance test are to be carried out with the fuel and lubricant defined in Chapter 3.

2.4.5. Each 100 hour period is to comprise ten 10 hour cycles. Each 10 hour cycle will be carried out in accordance with the programme (section 2.5).

2.4.6. Data will be recorded during the last five minutes of each of the sub-cycles included in the basic 10-hour cycle, with the exception of sub-cycles 3, 4, 7, 8, 10, 11.

2.4.7. No interruptions are permitted during any of the sub-cycles, but the engine may be switched off on completion of any sub-cycle.

2.4.8. One-hundred percent power (load) will be governed by maximum fuel control setting, not adjusted to published maximum power.

SECTION 2-5 - PROGRAMME OF 10 HOUR CYCLE

Period	Rated Speed %	Rated Load %	Duration (hours)
1	Idle (1)	Idle (1)	0,5
2	100	100	1
3	50 ⟷ 100 3 min 3 min	100	1
4	Stop		0,25
5	70	100	1
6	Idle	Idle	0,5
7	Idle ⟷ 100 2 min 3 min	Idle ⟷ 100	2
8	Stop		0,25
9	100	100	1
10	Stop		0,25
11	Idle ⟷ 100 2 min 3 min	Idle ⟷ 100	2
12	Idle	Idle	0,25
		Total	10

At least 5 times during each 100 hour period, the engine will be shut down for a minimum of 6 hours.

(1) Manufacturer's published idle or as specified by vehicle installation.

ANNEX A

DETAILS OF PRODUCTION AUXILIARY EQUIPMENT

Inlet System Air Filter System Inlet Silencer	Optional
Exhaust System Piping Silencer Exhaust Pipes	Test Bench Equipment
Fuel Feed Pump	Optional
Fuel Injection Equipment Prefilter Filter	Yes, or test bench equipment
Electrical Equipment	If necessary

ANNEX B

INFORMATION TO BE INCLUDED

IN TEST REPORT

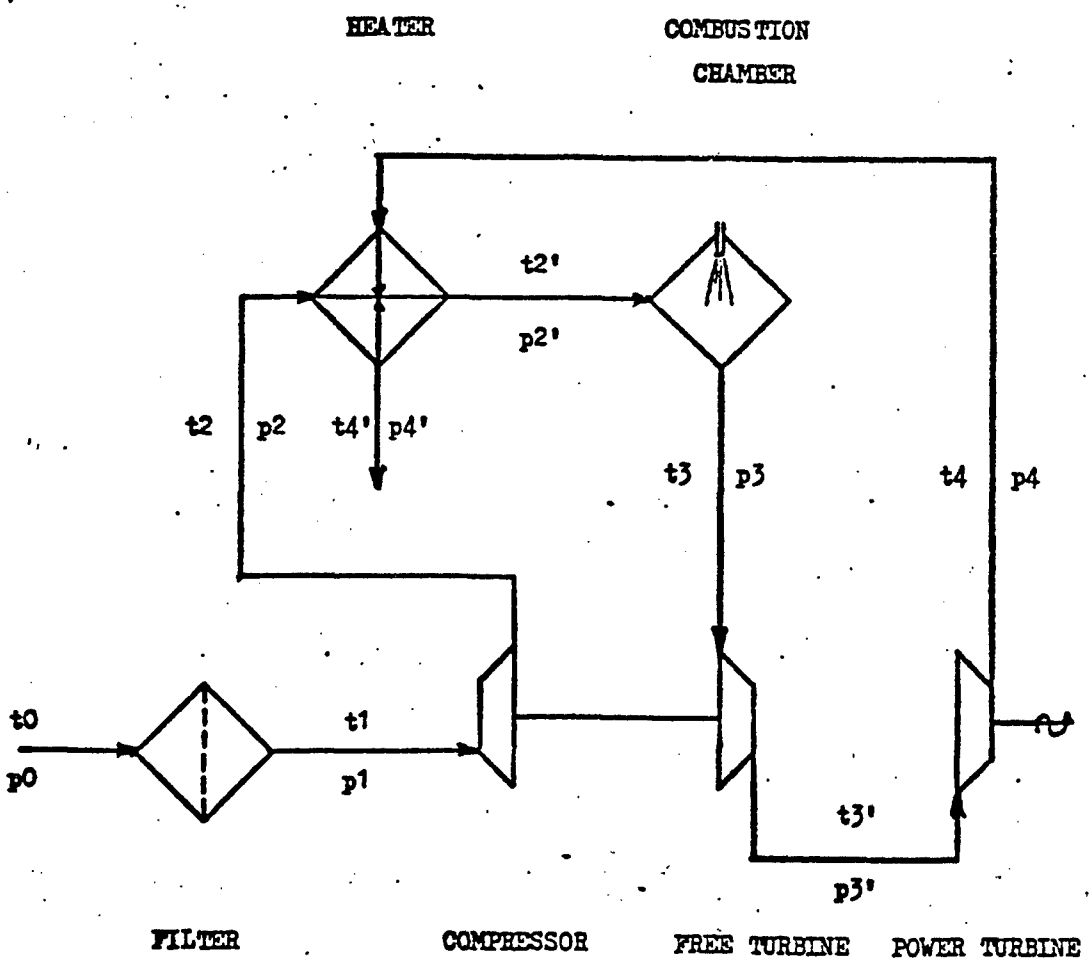
A complete report covering all the tests, servicing, maintenance, rectification of faults and the condition of the engine at the strip examination including the measurements of the principal wearing parts will be compiled.

The report will also include the following :

1. A statement of the build standard of the engine, with drawings and a parts list.
2. Photographs of the engine from four different views.
3. Photographs of the test installation at least four different views.
4. A list of equipment fitted to the engine.
5. Sample test sheets and a summary with a list of faults and the remedial action taken.
6. An engine condition report at end of test with photographs of the condition of major parts such as combustion chamber, compressor wheels and diffusers, turbine wheels and nozzles, reduction gear with any other components of interest.
7. A history chart of lubricating oil used during the endurance tests.
8. Analysis of new and used lubricating oil, the latter to be taken at approximately 100 hours intervals.
9. Fuel analysis.
10. Any other relevant data.

SCHEMATIC DIAGRAM

t0 and p0	:	embiente temperature and pression
t1 and p1	:	temperature and pression after filter
t2 and p2	:	" " after compressor
t2' and p2'	:	" " after heater
t3 and p3	:	" " after combustion chamber
t3' and p3'	:	" " after free turbine
t4 and p4	:	" " after power turbine
t4' and p4'	:	exhaust gas temperature and pression



— air

— gas

NATO STANDARD ENGINE LABORATORY TEST

(DIESEL and GASOLINE ENGINES)

AEP-5

EDITION JUNE 80

CHAPTER 1

PURPOSE AND APPLICABILITY

SECTION 1-1 - PURPOSE

The purpose of this document is to define a test method and standard conditions to enable all NATO countries to conduct tests using an identical method or to analyse the tests conducted in the laboratories of other NATO countries on the basis of this method.

The method described below is independent of existing national test methods, which may be used for supplementary testing.

When an engine has met the requirements of the tests under the present code, its power rating should be indicated as follows : "Power rating .... Kw (... metric HP) at .... r.p.m., in accordance with NATO code AEP 5. Edition June 1980".

SECTION 1-2 - APPLICABILITY

These test conditions apply to all service vehicle (combat and transport) propulsion Diesel and gasoline engines.

NOTE : SI units will be used.

CHAPTER 2

TEST REQUIREMENTS

SECTION 2-1 - GENERAL COMPOSITION AND ORDER OF TEST

2.1.1. Engine reception.

Running-in in accordance with manufacturer's instructions.

Performance test, complete (full and part loads).

Endurance test.

Performance test, complete (full and part loads).

Disassembly, inspection and measurement.

Report.

NOTES : (1) Engine measurements may be carried out before running-in.

(2) The manufacturer is responsible for defining the running-in programme and the engine should have been run-in before it is submitted for testing.

(3) In so far as possible, the manufacturer's drawings and technical data will be supplied with the engine, to assist inspection and measurement of components.

(4) It is normal practice for the engine to be given a preliminary performance test immediately after receipt, to check acceptability.

(5) The initial, if accomplished, and final inspection of the engine should be carried out by the same inspection team using the same gauges.

2.1.2. During performance and durability testing, the following variables will be monitored :

a - Main values
Speed
Torque (engine output shaft)

b - Ambient conditions
Temperature of ambient air
Atmospheric pressure
Humidity

c - Air and gases
Inlet air temperature
Induction or cylinder inlet depression
Inlet air flow (performance test only)
Air temperature and pressure in the inlet manifold
Exhaust temperature
Exhaust back-pressure
Gas temperatures at points influencing fuel control (if required)

d - Lubrication and cooling
Oil temperatures and pressures
Temperatures into and out of external coolers
Flow rates of fluids to cooling devices external to the engine (for heat rejection calculations)
Oil consumption (during endurance tests only)

e - Fuel
Fuel temperature
Fuel consumption

f - Miscellaneous
Blow-by
Smoke density

2.1.3. Regulated parameters

Outlet liquid coolant temperatures :
96°C ± 3°C

Induction depression at rated power :
25 ± 5 mbar

Exhaust back pressure at rated power :
40 mbar ± 5

Fuel temperature at injection pump inlet :
30°C ± 3°C

2.1.4. TEST CONDITIONS

Measuring is to be done in normal and stable operating conditions.

The temperature of the air entering the engine (ambient air) is to be measured at a maximum distance of 0,15 m from the air filter inlet or, if there is no filter, 0,15 m from the air inlet nozzle. The thermometer or thermocouple must be protected against heat radiation and be located directly in the air jet. Testing must be carried out in an adequate number of positions to give a representative inlet temperature.

Once an output speed has been selected for measurement purposes, its value must not vary by more than ± 1 % or ± 10 r.p.m. (whichever of these limits is the higher) during measurement.

The readings for brake load, fuel consumption and inlet air temperature are to be taken simultaneously, the value recorded being the average of two stabilized results, obtained in succession with brake load and fuel consumption differing by less than 2 %.

When a device fitted with an automatic starting system is used for measuring speed and consumption, the duration of measurement must be at least 30 seconds ; if the measuring device is manually operated, the duration must be at least 60 seconds.

The exhaust gas outlet temperature must be measured at a point downstream and less than 100 mm from the flange (s) of the exhaust manifold (s).

Lubricant temperature is to be measured at the inlet and outlet of the heat exchanger if there is one. Otherwise it must be take preferably in the lubrication system, or, failing this, in the crank case. The measuring point will be specified in the test report.

Fuel temperature must be read at the injection pump inlet, or carburettor inlet.

Cooling condition for air cooled engine will be in accordance with manufacturers specification.

Auxiliary power take-offs may be loaded and mesured if desired

2.1.5. MEASUREMENT ACCURACY

- TORQUE

  The torque must be accurate within ± 0,5 % of the highest value to be measured.

- OUTPUT SPEED

  Measurement must be accurate to within ± 0,5 %.

- FUEL CONSUMPTION

  ± 1 % for all apparatus used.

- TEMPERATURES

  Intake air ± 1°C.

- PRESSURE

  Atmospheric pressure ± 0.7 mbar
  Air and gas pressure ± 50 mbar
  Induction and exhaust pressure and depression ± 0,250 mbar
  Pressure of other fluids ± 250 mbar

SECTION 2-2 - DEFINITION OF ENGINE

Engines will be equipped only with such auxiliary equipment as is strictly essential to their operation (see table of auxiliary equipment at Annex A).

SECTION 2-3 - PERFORMANCE TEST

The performance test maximum load curve will be plotted from measurements taken at a minimum of five speed settings, the fifth setting being the rated speed.

For each setting, the engine should be run for a sufficient time to allow the operating parameters to stabilize.

Part-load data is to be recorded at the same pre-selected speed as was used for the full-load test. The part loads for each speed point are to be calculated at least for 85 %, 70 %, 50 % and 25 % of the full load at the given speed.

During this test, the smoke emission as measured on the Robert BOSCH Scale (or equivalent) shall not exceed 4.5.

No correction factor will be applied and the test results must include air temperature and atmospheric pressure.

The inlet air temperature shall be maintained as close as possible to 25°C.

SECTION 2-4 - ENDURANCE TEST

2.4.1. The endurance test duration is 400 hours, divided into four periods of 100 hours each. At the completion of each period, the engine shall be submitted to a full-load performance check.

2.4.2. Normal maintenance and adjustment will be permissible after each 100 hour test period.

2.4.3. Engine oil and filters shall be changed after each 100 hour period.

2.4.4. The coolant outlet temperature is to be held at 96°C ± 3°C or a higher temperature if proposed by the manufacturer. The coolant is to be water plus antifreeze in egal volume.

2.4.5. The engine oil temperature is to be measured in the lubrication system. The temperature measurement location shall be specified.

2.4.6. The four 100 hour periods which make up the endurance test are to be carried out with the reference fuel defined in Chapter 3.

2.4.7. Each 100 hour period is to comprise ten 10 hour cycles. Each 10 hour cycle will be carried out in accordance with the programme (section 2-5).

2.4.8. Data will be recorded during the last five minutes of each of the sub-cycles included in the basic 10 hours cycle, with the exception of sub-cycle 5.

2.4.9. No interruptions are permitted during any of the sub-cycles, but the engine may be switched off on completion of any sub-cycle.

SECTION 2-5 - PROGRAMME OF 10 HOUR CYCLE

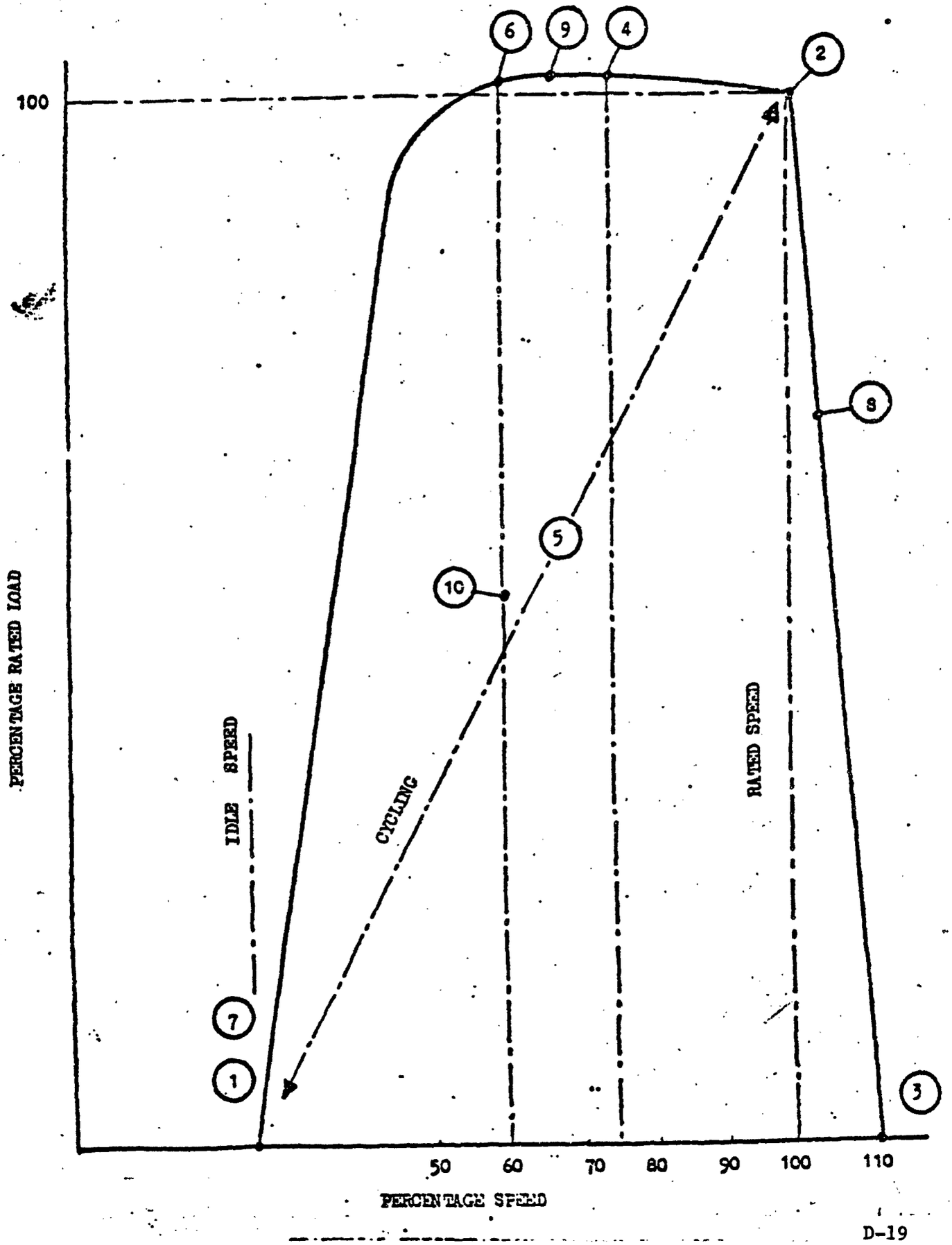
Sub Cycle	% Rated Speed	% Load (3)	Duration in hours
1	IDLE	0	½
2	100	100	2
3	governed speed (1)	0	½
4	75	100	1
5	IDLE ⟷ 100	0 ⟷ 100 4 MIN 6 MIN	2
6	60	100	½
7	IDLE	0	½
8	governed speed (2)	70 (3)	½
9	Max torque speed	100	2
10	60	50 (3)	½
		Total	10

NOTES :

(1) The speed shall be that attained with the engine at full throttle and with minimum load (residual brake load).

(2) The speed shall be the steady speed of the engine at full throttle and 70 % load.

(3) Part loads (70 and 50 %) shall be taken from the initial performance test.


6
9
4
2
100
8
5
10
PERCENTAGE RATED LOAD
IDLE SPEED
CYCLING
RATED SPEED
7
1
3
50
60
70
80
90
100
110
PERCENTAGE SPEED

CHAPTER 3

FUELS AND LUBRICANTS AND ANTIFREEZES

301 Engines are to be tested on Reference Fuels and Lubricants and antifreezes as specified by the relevant NATO Authority.

CHAPTER 4

DEFINITION OF TEST FAILURE

401 A major failure is a failure of any part or component of the engine assembly that leads to a final stoppage of the test or that brings about as loss of power which cannot be rectified to give at least 95 % of rated power.

Any major failure will lead to termination of the test and any retest must start at 0 hour.

Major failures and corrective action are to be reported to the proper National Authority.

402 A minor failure is a defect which leads to a loss of power or degradation of the operation of the engine and which it is possible to remedy within the scope of normal maintenance and adjustment. If 95 % of the rated power cannot be obtained after normal maintenance then the test will be terminated. The minor failures and the measures taken to overcome them must be included in the report.

403 The suitability of an engine for NATO AEP5 Approval is to be the responsibility of the National Authorities after completion of the 400 hours test and consideration of the final condition of the engine.

ANNEXE A

DETAILS OF PRODUCTION AUXILIARY EQUIPMENT

(To be included as applicable)

Inlet system	
Inlet manifold	Yes
Air filter	Optional
Inlet silencer	Optional
Blowby gas recirculation intake ...	Optional
Exhaust system	
Manifold	Yes
Piping	Test bench equipment
Silencer	Test bench equipment
Exhaust pipes	Test bench equipment
Fuel feed pump	Yes
Carburettor	Yes (details of adjustment will be specified)
Ignition system	
Distributor	Yes
Spark-plugs	Yes
Coils	Yes
Suppressor	Yes
Fuel injection equipment	
Prefilter	Yes or test bench equipment
Filter	Yes or test bench equipment
Pump	Yes
High-pressure pipes	Yes
Injector	Yes

Liquid cooling equipment	
Radiator	No
Fan	
Water pump	Yes
Thermostat	Yes
Air cooling equipment	
Streamlining	Yes
Blower	Yes
Temperature regulating device	Yes
Electrical equipment	If necessary
Supercharging equipment	
Compressor driven directly or indirectly by the engine and/or exhaust gas	Yes
Charge cooler	Yes
Cooling pump or fan ..... (engine driven)	Yes
Device for regulating flow of cooling fluid	Yes

ANNEX B

INFORMATION TO BE INCLUDED

IN TEST REPORT

A complete report covering all the tests, servicing, maintenance, rectification of faults and the condition of the engine at the strip examination including the measurements of the principal wearing parts will be compiled.

The report will also include the following :

1. A statement of the build standard of the engine, with drawings and a parts list.

2. Photographs of the engine from four different views.

3. Photographs of the test installation at least four different views.

4. A list of equipment fitted to the engine.

5. Sample test sheets and a summary with a list of faults and the remedial action taken.
   Full load performance data will be show in the format indicated.

6. An engine condition report at end of test with photographs of the condition of major parts such as pistons, bearings, valves, camshafts, crankshafts, cylinder bores together with any other components of interest.

7. A history chart of lubricating oil used during the endurance tests.

8. Analysis of new and used lubricating oil, the latter to be taken at approximately 100 hours intervals.

9. Fuel analysis.

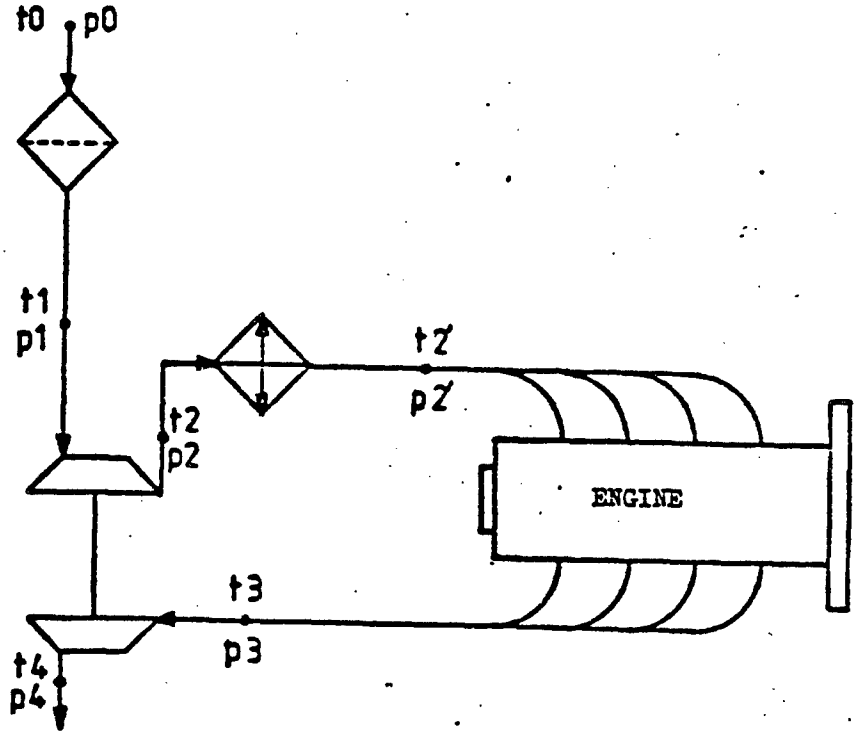
10. Any other relevant data.

ENGINE Type:	N°:	Place date:
FULL CHARGE PERFORMANCES INITIAL ☐ FINAL ☐		Reference:
FUEL:	OIL type:	BRAKE type:
Volume mass: kg/dm³	grade:	

AMBIENT	t0	°C								
	p0	mbar								
PERFORMANCE	n	r.p.m								
	M	m.daN								
	p	kw								
	pme	bar								
FUEL	Cs/bsfc	g/kw.h								
	Qc	mm^3/cycle								
	qm	kg/h								
OIL	tH	°C								
	pH	Bar								
WATER	te	°C								
	ts	°C								
INLET	t1	°C								
	p0 - p1	mbar								
	t2	°C								
	p2	bar								
	t2'	°C								
	p2 - p2'	mbar								
EXHAUST	t3	°C								
	p3	bar								
	t4	°C								
	p4 - p0	mbar								
	Smoke	Bosch								
BLOW - BY		cm^3/mn								

DEFINITION OF SHORTS

- t0 : ambient temperature
- p0 : ambient pressure
- n : engine speed
- M : engine torque
- P : output power
- pme/bmep: brake mean effective pressure
- Cs/bsfc : specific fuel consumption
- Qc : volume of fuel per injection
- qm : mass fuel flow per hour
- tH : oil temperature
- pH : oil pressure
- te : coolant temperature into engine
- ts : coolant temperature out of engine
- t1 : air temperature after filter (or compressor inlet)
- p0 - p1 : inlet depression
- t2 : compressor discharge temperature
- p2 : compressor discharge pressure
- t2' : air temperature after charge cooler
- p2 - p2' : pressure of across charge cooler
- t3 : exhaust gaz temperature (turbine inlet)
- p3 : exhaust gaz pressure (turbine inlet)
- t4 : turbine discharge temperature
- p4 - p0 : Exhaust back pressure



APPENDIX E

LUBE OIL SPECTROGRAPHIC ANALYSIS

OIL ANALYSIS REQUEST

KEYPUNCH CODE

TO	OIL ANALYSIS LAB: PETROLEUM FIELD OFFICE EAST STSGP-PE	1-3
FROM	MAJOR COMMAND: TACOM	4
FROM	OPERATING ACTIVITY (Include ZIP Code/APO) DODAAD: DRSTA-RGES VINCENT NESTICO WARREN, MI 48090 AV: 786-8537	5-10
	EQUIPMENT MODEL/APL: CUMMINS VT-504-C Diesel Eng	
	EQUIPMENT SER. NO.: 20227520	15-20
	END ITEM MODEL/HULL NO.: CADILLAC CASE M730/M728	
	END ITEM SER. NO./EIC: NONE	
	DATE SAMPLE TAKEN (Day, Mo., Yr.): 06 JUL 1982 — LOCAL TIME SAMPLE TAKEN	21-24
	HOURS/MILES SINCE OVERHAUL: 225 HOURS / 400 Hour NATO TEST	25-29
	HOURS/MILES SINCE OIL CHANGE: 25 T.T HOURS	30-33
	REASON FOR SAMPLE: [X] ROUTINE [ ] LAB REQUEST [ ] TEST CELL [ ] OTHER (Specify)	34
	ODDED SINCE LAST SAMPLE (Pts, Qts, Gals)	35-36
	KEN	
	ITEM	
	ICTIONED	
	[ ] LAB REQUEST [ ] AIR OR GROUND CREW	
	...OW TAKEN: [ ] DRAIN [X] TUBE — SAMPLE TEMPERATURE: [X] HOT [ ] COLD — TYPE OIL: MIL-L-2104C	37-38

REMARKS: Oil sample spectrographic analysis is required for NATO 400 Hour Test. Specification standards and samples will be taken every 25 hours. Complete oil change at every endurance 705/7d

FOR LAB USE ONLY

SAMPLE RESPONSE TIME						
						39-40
FE 41-43	AG 44-46	AL 47-49	CR 50-52	CU 53-55	MG 56-58	NI 59-61
28	0	0	3	3	489	0
PB 62-64	SI 65-67	SN 68-70	TI 71-72	MO 74-76		
19	10	2	0	0		

LAB RECOMMENDATION: do not stamp — 77-78

SAMPLE NO.	SIGNATURE	FILE MAINT	DATA SEQ
1146		79	80

DD FORM 1 NOV 77 2026 PREVIOUS EDITION WILL BE USED

OIL ANALYSIS REQUEST

KEYPUNCH CODE

TO	OIL ANALYSIS LAB: PETROLEUM FIELD OFFICE EAST STSGP-PE	1-3
FROM	MAJOR COMMAND: TACOM	4
FROM	OPERATING ACTIVITY (Include ZIP Code/APO) DODAAD: DRSTA-RGES VINCENT NESTICO WARREN, MI 48090 AV: 786-8537	5-10
	EQUIPMENT MODEL/APL: CUMMINS VT-504-C Diesel En	11-14
	EQUIPMENT SER. NO.: 20227520	15-20
	END ITEM MODEL/HULL NO.	
	END ITEM SER. NO./EIC	
	DATE SAMPLE TAKEN (Day, Mo., Yr) / LOCAL TIME SAMPLE TAKEN	21-24
	HOURS/MILES SINCE OVERHAUL: 400 Hour NATO TEST	25-29
	HOURS/MILES SINCE OIL CHANGE: 50 HOURS	30-33
	REASON FOR SAMPLE: ☐ LAB REQUEST ☐ TEST CELL ☐ OTHER (Specify)	34
	LAST SAMPLE (Pts, Qts, Gals)	35-36
	343 NED	
	HOW ☐ LAB REQUEST ☐ AIR OR GROUND CREW	
	HOW TAKEN: ☐ DRAIN ☒ TUBE / SAMPLE TEMPERATURE: ☒ HOT ☐ COLD / TYPE OIL: MIL-L-2104-C	37-38

REMARKS: Oil sample spectrographic analysis is required for NATO 400 Hour Test. Specification standards and samples will be taken every 25 hours. Complete oil change at every endurance

FOR LAB USE ONLY

SAMPLE RESPONSE TIME: 2-29-73 — 39-40

FE 41-43	AG 44-46	AL 47-49	CR 50-52	CU 53-55	MG 56-58	NI 59-61
34	C	C	12	44	39	C

PB 62-64	SI 65-67	SN 68-70	TI 71-73	MO 74-76	
17	7	C	C	C	

LAB RECOMMENDATION — 77-78

SAMPLE NO.	SIGNATURE	FILE MAINT	DATA SEQ
0343		79	80

DD FORM 1 NOV 77 2026 PREVIOUS EDITION WILL BE USED

OIL ANALYSIS REQUEST

KEYPUNCH CODE

TO	OIL ANALYSIS LAB: PETROLEUM FIELD OFFICE EAST STSGP-PE	1-3
FROM	MAJOR COMMAND: TACOM	4
FROM	OPERATING ACTIVITY (Include ZIP Code/APO) DODAAD: DRSTA-RGES VINCENT NESTICO WARREN, MI 48090 AV: 786-8537	5-10
EQUIPMENT MODEL/APL: CUMMINS VT-504-C Diesel En		11-14
EQUIPMENT SER. NO.: 20227520		15-20
END ITEM MODEL/HULL NO.: ?		
END ITEM SER. NO./EIC: ?		
DATE SAMPLE TAKEN (Day, Mo., Yr.)	LOCAL TIME SAMPLE TAKEN	21-24
HOURS/MILES SINCE OVERHAUL: 400 Hour NATO TEST		25-29
HOURS/~~MILES SINCE OIL CHANGE~~: 125		30-33

REASON FOR SAMPLE: ☐ ROUTINE ☐ LAB REQUEST ☐ TEST CELL ☐ OT

OIL ADDED SINCE LAST SAMPLE (Pts, Qts, Gals)

ACTION TAKEN

DISCREPANT ITEM

HOW MALFUNCTIONED

HOW FOUND: ☐ LAB REQUEST ☐ AIR OR GROUND CREW

HOW TAKEN	SAMPLE TEMPERATURE	TYPE OIL	37-38
☐ DRAIN ☒ TUBE	☒ HOT ☐ COLD	MIL-L-21260C	

2549

REMARKS: Oil sample spectrographic analysis is required for NATO 400 Hour Test. Specification standards and samples will be taken every 25 hours. Complete oil change at every endurance 23/73

FOR LAB USE ONLY

SAMPLE RESPONSE TIME: 39-40

FE 41-43	AG 44-46	AL 47-49	CR 50-52	CU 53-55	MG 56-58	NI 59-61
22	0	0	7	36	44	0

PB 62-64	SI 65-67	SN 68-70	TI 71-73	MO 74-76	
14	8	0	0	0	

LAB RECOMMENDATION: 77-78

SAMPLE NO.	SIGNATURE	FILE MAINT	DATA SEQ
2549		79	80

DD FORM 1 NOV 77 2026 PREVIOUS EDITION WILL BE USED

OIL ANALYSIS REQUEST

KEYPUNCH CODE

TO: OIL ANALYSIS LAB: FORT ORD OIL LAB AFZW-DI-MT- — 1-3: 1002

FROM:
- MAJOR COMMAND: TACOM — 4
- OPERATING ACTIVITY (Include ZIP Code/APO) DODAAD: DRSTA-RGES, WARREN, MI 48090 — VINCENT NESTICO, AV: 786-8537 — 5-10

EQUIPMENT MODEL/APL: CUMMINS VT-504-C Diesel Eng — 11-14

EQUIPMENT SER. NO.: 20227520 — 15-20

END ITEM MODEL/HULL NO.:

END ITEM SER NO./ERC: 250 HRS ENDURANCE

DATE SAMPLE TAKEN (Day, Mo., Yr.): 13 JULY 82 — LOCAL TIME SAMPLE TAKEN: 1415 — 21-24

HOURS/MILES SINCE OVERHAUL: 400 Hour NATO TEST — 25-29

HOURS/MILES SINCE OIL CHANGE — 30-33

REASON FOR SAMPLE: ☐ ROUTINE ☐ LAB REQUEST ☐ TEST CELL ☐ OTHER (Specify) — 34

OIL ADDED SINCE LAST SAMPLE (Pts, Qts, Gal.) — 35-36

ACTION TAKEN: PROCESSED 16 JUL 1982

DISCREPANT ITEM

HOW MALFUNCTION: RESULTS - NORMAL

HOW FOUND: ☐ LAB REQUEST ☐ AIR OR GROUND CREW

HOW TAKEN	SAMPLE TEMPERATURE	TYPE OIL	37-38
☐ DRAIN ☒ PUMP	☒ HOT ☐ COLD	MIL-L-2104C	1

REMARKS: Oil sample spectrographic analysis is required for NATO 400 Hour Test. Specification standards and samples will be taken every 25 hours. Complete oil change at every endurance

FOR LAB USE ONLY

SAMPLE RESPONSE TIME — 39-40

FE 41-43	AG 44-46	AL 47-49	CR 50-52	CU 53-55	MG 56-58	NI 59-61
30			9	22	177	

PB 62-64	SI 65-67	SN 68-70	TI 71-73	MO 74-76		
19	C				33	D 2

LAB RECOMMENDATION — ~~78-80~~ VIS 259

SAMPLE NO.	SIGNATURE	FILE MAINT 79	DATA SEQ 80

DD FORM 1 NOV 77 2026 PREVIOUS EDITION WILL BE USED

OIL ANALYSIS REQUEST

KEYPUNCH CODE

TO	OIL ANALYSIS LAB: FORT ORD OIL LAB AFZW-DI-MT	1-3
FROM	MAJOR COMMAND: TACOM	4
FROM	OPERATING ACTIVITY (Include ZIP Code/APO) DODAAD: DRSTA-RGES VINCENT NESTICO WARREN, MI 48090 AV: 786-8537	5-10 1329
	EQUIPMENT MODEL/APL: CUMMINS VT-504-C Diesel Eng	11-14
	EQUIPMENT SER. NO.: 20227520	15-20
	END ITEM MODEL/HULL NO.	
	END ITEM SER. NO./EIC	
	DATE SAMPLE TAKEN (Day, Mo., Yr): 15 JUN 82 — LOCAL TIME SAMPLE TAKEN: 1430	21-24
	HOURS/MILES SINCE OVERHAUL: 400 Hour NATO TEST	25-29
	HOURS/~~MILES~~ SINCE OIL CHANGE: 300	30-33
	REASON FOR SAMPLE: ☐ ROUTINE ☐ LAB REQUEST ☐ TEST CELL ☐ OTHER (Specify)	34
	OIL ADDED SINCE LAST SAMPLE (Pts, Qts, Gals): 1.5 QTS	35-36
	ACTION TAKEN: PROCESSED 23 JUL 1982	
	DISCREPANT ITEM	
	HOW MALFUNCTIONED: RESULTS - NORMAL	
	HOW FOUND: ☐ LAB REQUEST ☐ AIR OR GROUND CREW	
	HOW TAKEN: ☐ DRAIN ☒ TUBE — SAMPLE TEMPERATURE: ☒ HOT ☐ COLD — TYPE OIL: MIL-L-2104C	37-38 1

REMARKS: Oil sample spectrographic analysis is required for NATO 400 Hour Test. Specification standards and samples will be taken every 25 hours. Complete oil change at every endurance

FOR LAB USE ONLY

SAMPLE RESPONSE TIME						39-40
FE 41-43	AG 44-46	AL 47-49	CR 50-52	CU 53-55	MG 56-58	NI 59-61
PB 62-64	SI 65-67	SN 68-70	TI 71-73	MO 74-76		
LAB RECOMMENDATION						77-78
SAMPLE NO.	SIGNATURE			FILE MAINT 79		DATA SEQ 80

DD FORM 1 NOV 77 2026 PREVIOUS EDITION WILL BE USED

OIL ANALYSIS REQUEST

KEYPUNCH CODE

TO	FORT ORD OIL LAB AFZW-DI-MT	1-3
FROM	MAJOR COMMAND TACOM	4
FROM	OPERATING ACTIVITY (Include ZIP Code/APO) DODAAD DRSTA-RGES VINCENT NESTICO WARREN, MI 48090 AV: 786-8537	5-10 1480
	EQUIPMENT MODEL/APL CUMMINS VT-504-C Diesel Eng	11-14
	EQUIPMENT SER. NO. 20227520	15-20
	END ITEM MODEL/HULL NO.	
	END ITEM SER. NO./EIC	
	DATE SAMPLE TAKEN (Day, Mo., Yr.) 3 JUN 82 / LOCAL TIME SAMPLE TAKEN 1000	21-24
	HOURS/MILES SINCE OVERHAUL 400 Hour NATO TEST	25-29
	HOURS/MILES SINCE OIL CHANGE	30-33
	REASON FOR SAMPLE ☐ ROUTINE ☐ LAB REQUEST ☐ TEST CELL ☐ OTHER (Specify)	34
	OIL ADDED SINCE LAST SAMPLE (Pts, Qts, Gals) 1/2 qt.	35-36
	ACTION TAKEN 350 Test hours	
	DISCREPANT ITEM PROCESSED [illegible] 1982	
	HOW MALFUNCTIONED RESULTS - NORMAL	
	HOW FOUND ☐ LAB REQUEST ☐ AIR OR GROUND CREW	
	HOW TAKEN ☐ DRAIN ☑ TUBE / SAMPLE TEMPERATURE ☐ HOT ☐ COLD / TYPE OIL [illegible]	37-38

REMARKS Oil sample spectrographic analysis is required for NATO 400 Hour Test. Specification standards and samples will be taken every 25 hours. Complete oil change at every endurance

FOR LAB USE ONLY

SAMPLE RESPONSE TIME						39-40
FE 41-43	AG 44-46	AL 47-49	CR 50-52	CU 53-55	MG 56-58	NI 59-61
PB 62-64	SI 65-67	SN 68-70	TI 71-73	MO 74-76		
LAB RECOMMENDATION						77-78
SAMPLE NO.	SIGNATURE		FILE MAINT 79			DATA SEQ 80

DD FORM 1 NOV 77 2026 PREVIOUS EDITION WILL BE USED

OIL ANALYSIS REQUEST

KEYPUNCH CODE

TO	OIL ANALYSIS LAB: PETROLEUM FIELD OFFICE EAST STSGP-PE	1-3
FROM	MAJOR COMMAND: TACOM	4
FROM	OPERATING ACTIVITY (Include ZIP Code/APO) DODAAD: DRSTA-RGES VINCENT NESTICO WARREN, MI 48090 AV: 786-8537	5-10
	EQUIPMENT MODEL/APL: CUMMINS VT-504-C Diesel Eng	11-14
	EQUIPMENT SER. NO.: 20227520	15-20
	END ITEM MODEL/HULL NO.:	
	END ITEM SER. NO./EIC:	
	DATE SAMPLE TAKEN (Day, Mo., Yr): 26 JULY 82 / LOCAL TIME SAMPLE TAKEN	21-24
	HOURS/MILES SINCE OVERHAUL: 400 Hour NATO TEST	25-29
	HOURS/MILES SINCE OIL CHANGE	30-33
	REASON FOR SAMPLE: ☐ ROUTINE ☐ LAB REQUEST ☐ TEST CELL ☐ OTHER (Specify)	34
	SINCE LAST SAMPLE (Pts, Qts, Gals): 0 / 376 HOURS	35-36
	28 Aug 82	
	SIGNED	
2977	☐ LAB REQUEST ☐ AIR OR GROUND CREW	
	HOW TAKEN: ☐ DRAIN ☒ TUBE / SAMPLE TEMPERATURE: ☐ HOT ☐ COLD / TYPE OIL: MIL-L-2104C	37-38

REMARKS: Oil sample spectrographic analysis is required for NATO 400 Hour Test. Specification standards and samples will be taken every 25 hours. Complete oil change at every endurance

FOR LAB USE ONLY

SAMPLE RESPONSE TIME: 11/5/82						39-40
FE 41-43: 24	AG 44-46: 0	AL 47-49: 0	CR 50-52: 4	CU 53-55: 7	MG 56-58: 453	NI 59-61: 0
PB 62-64: 15	SI 65-67: 3	SN 68-70: 0	TI 71-73: 0	MO 74-76: AUG 8 1982		
LAB RECOMMENDATION: RESULTS						77-78
SAMPLE NO.: 2977	SIGNATURE			FILE MAINT		DATA SEQ

DD FORM 1 NOV 77 2026 PREVIOUS EDITION WILL BE USED

OIL ANALYSIS REQUEST

KEYPUNCH CODE

TO	OIL ANALYSIS LAB: PETROLEUM FIELD OFFICE EAST STSOP-PE	1-3
FROM	MAJOR COMMAND: TACOM	4
FROM	OPERATING ACTIVITY (Include ZIP Code/APO) DODAAD: DRSTA-RGES VINCENT NESTICO WARREN, MI 48090 AV: 786-8537	5-10
	EQUIPMENT MODEL/APL: CUMMINS VT-504-C Diesel Eng	11-14
	EQUIPMENT SER. NO.: 20227520	15-20
	END ITEM MODEL/HULL NO.:	
	END ITEM SER. NO./EIC:	
	DATE SAMPLE TAKEN (Day, Mo., Yr): / LOCAL TIME SAMPLE TAKEN:	21-24
	HOURS/MILES SINCE OVERHAUL: 400 Hour NATO TEST	25-29
	HOURS/MILES SINCE OIL CHANGE:	30-33
	REASON FOR SAMPLE: ☐ ROUTINE ☐ LAB REQUEST ☐ TEST CELL ☐ OTHER (Specify)	34
	OIL ADDED SINCE LAST SAMPLE (Pts, Qts, Gals):	
	ACTION TAKEN: 400 Hours con	
	DISCREPANT ITEM:	
	HOW MALFUNCTIONED:	
	HOW FOUND: ☐ LAB REQUEST ☐ AIR OR GROUND	
	HOW TAKEN: ☐ DRAIN ☒ TUBE / SAMPLE TEMPERATURE: ☒ HOT ☐ COLD / TYPE OIL: MIL-L-2104C	35-39

REMARKS: Oil sample spectrographic analysis is required for NATO 400 Hour Test. Specification standards and samples will be taken every 25 hours. Complete oil change at every endurance

FOR LAB USE ONLY

SAMPLE RESPONSE TIME: REQUESTED — 35-40

FE 41-43	AG 44-46	AL 47-49	CR 50-52	CU 53-55	MG 56-58	NI 59-61
22	0	0	6	1982	751	0

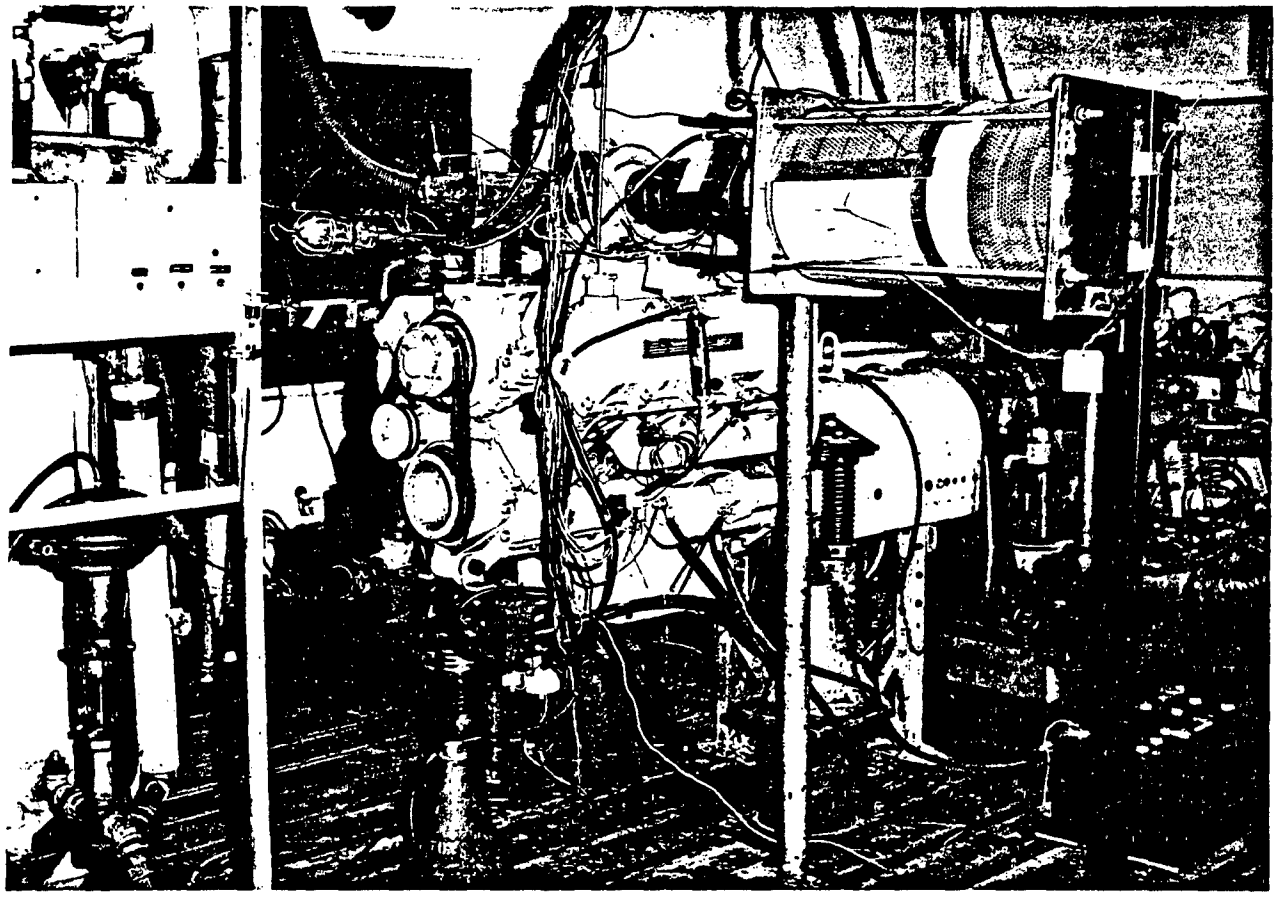
PB 62-64	SI 65-67	SN 68-70	TI 71-73	MO 74-76	NA
31	3	0	0	0	20

LAB RECOMMENDATION: RESULTS - NO... — 77-78

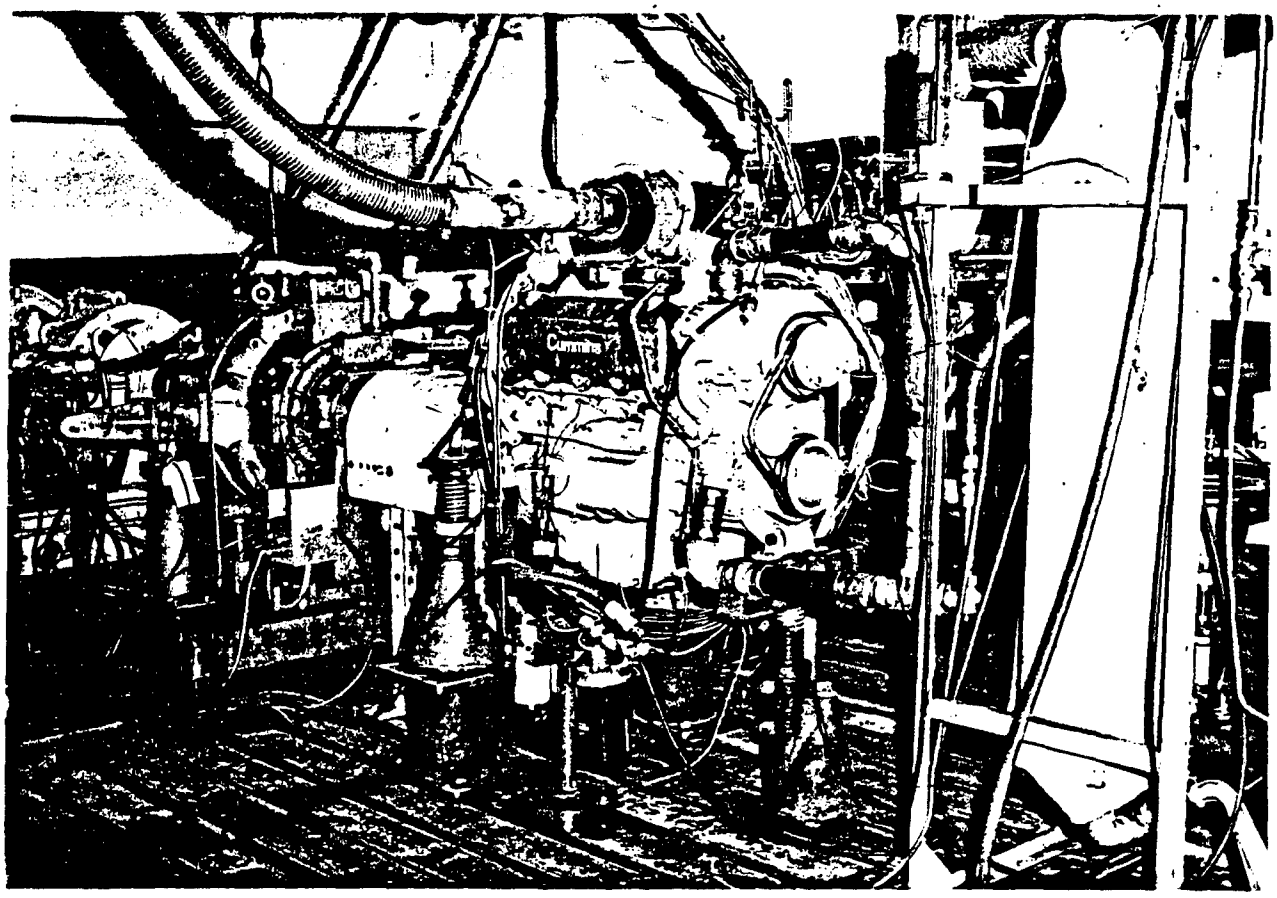
SAMPLE NO.	SIGNATURE	FILE MAINT	DATA SEQ
389		79	80

DD FORM 1 NOV 77 2026 PREVIOUS EDITION WILL BE USED

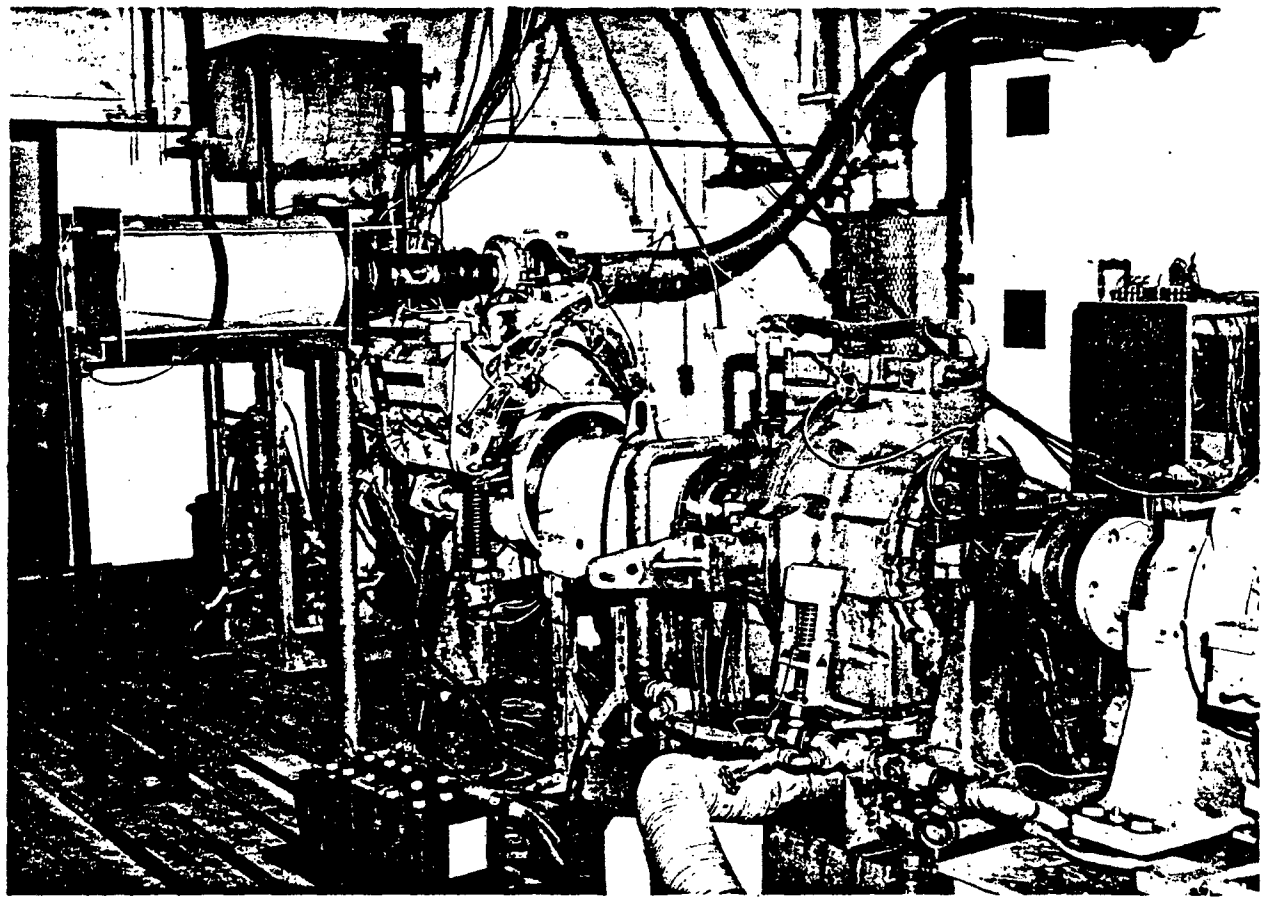
APPENDIX F - PHOTOGRAPHS



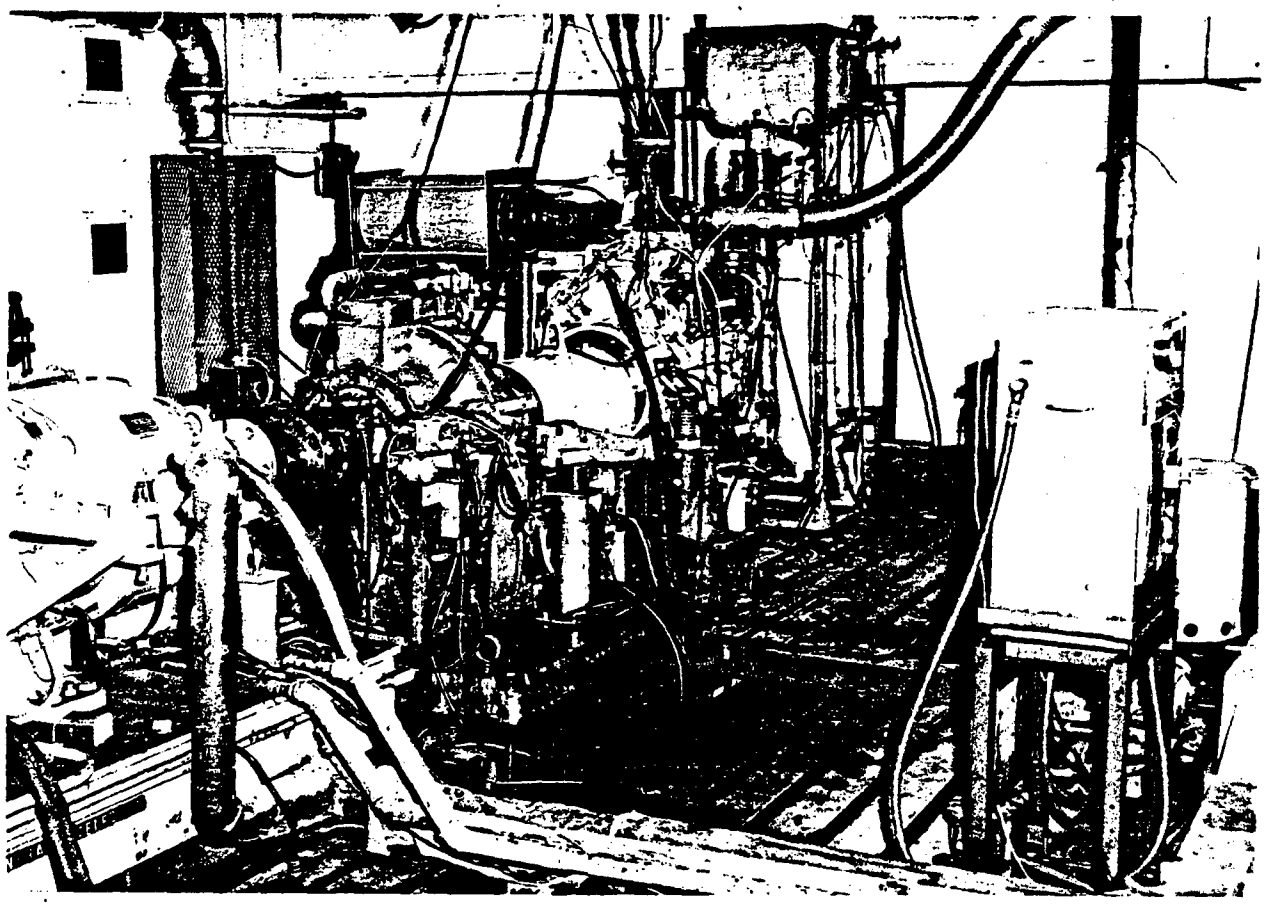
TEST SETUP - LEFT FRONT



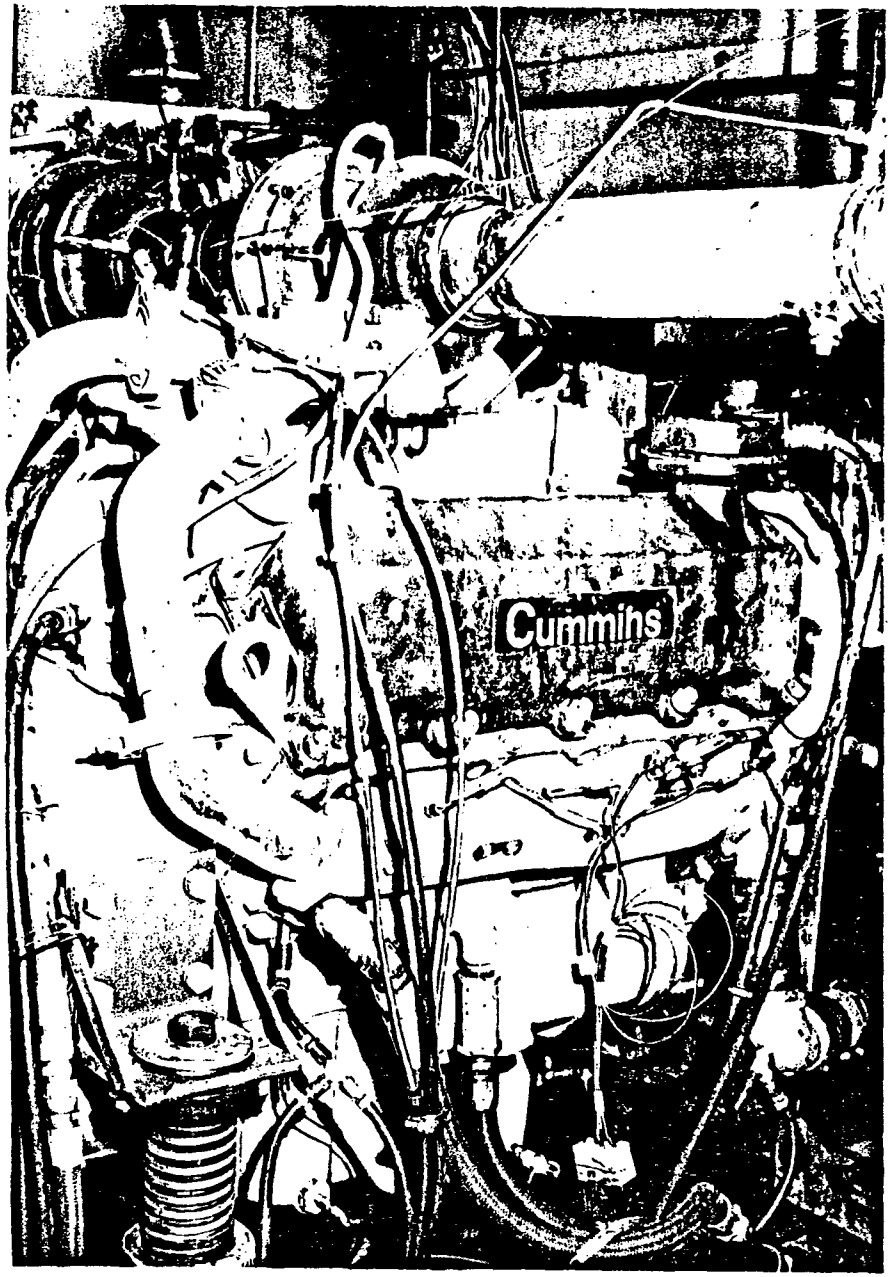
TEST SETUP - RIGHT FRONT



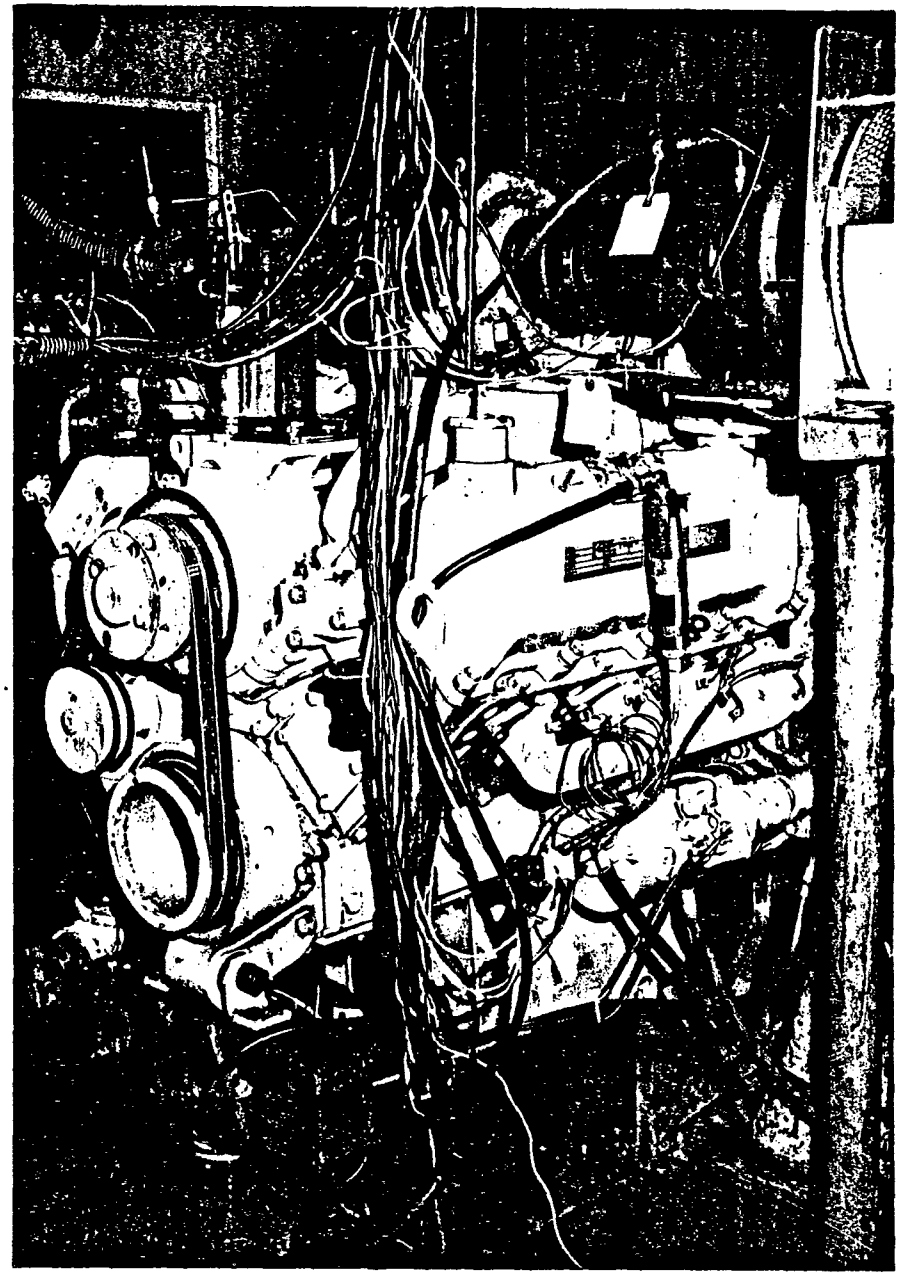
TEST SETUP - LEFT REAR



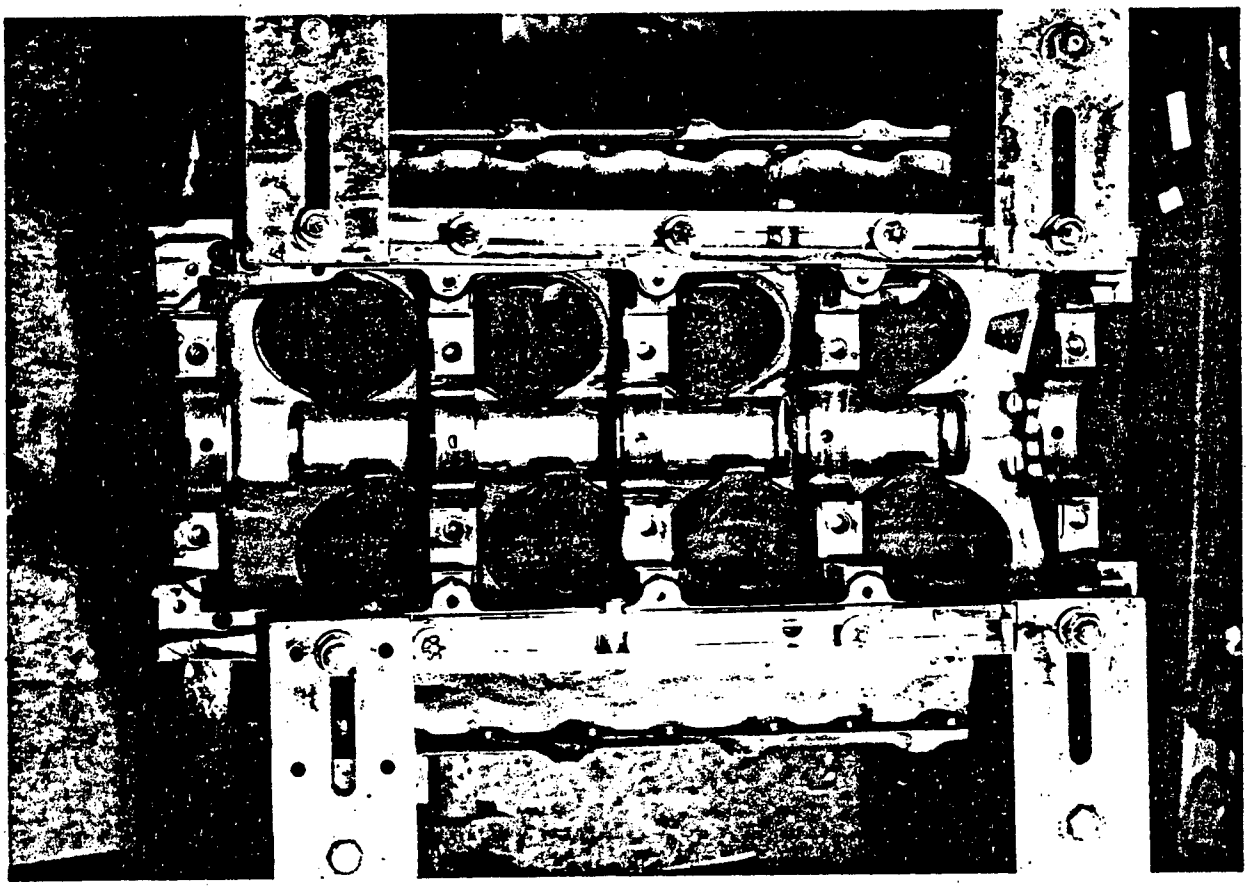
TEST SETUP - RIGHT REAR

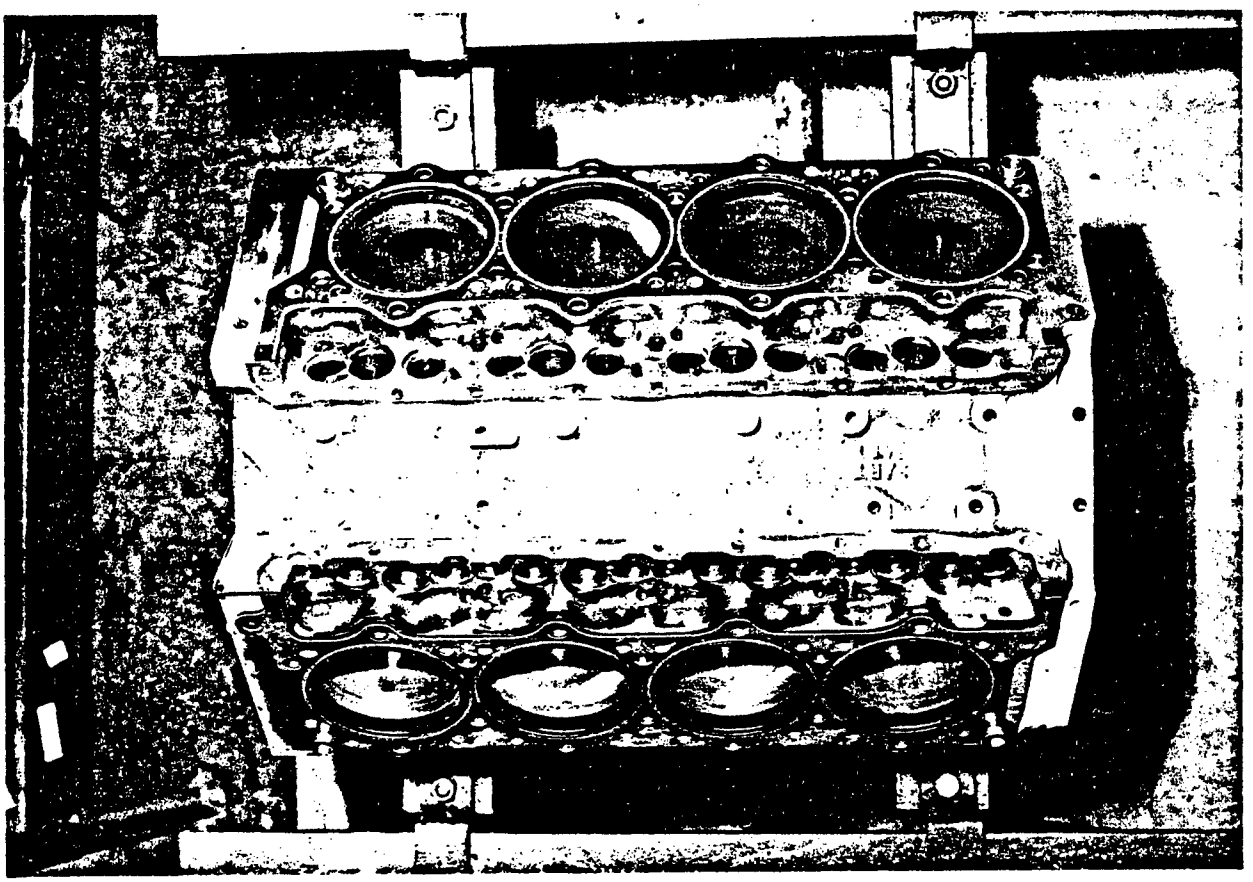


TEST SETUP - RIGHT SIDE

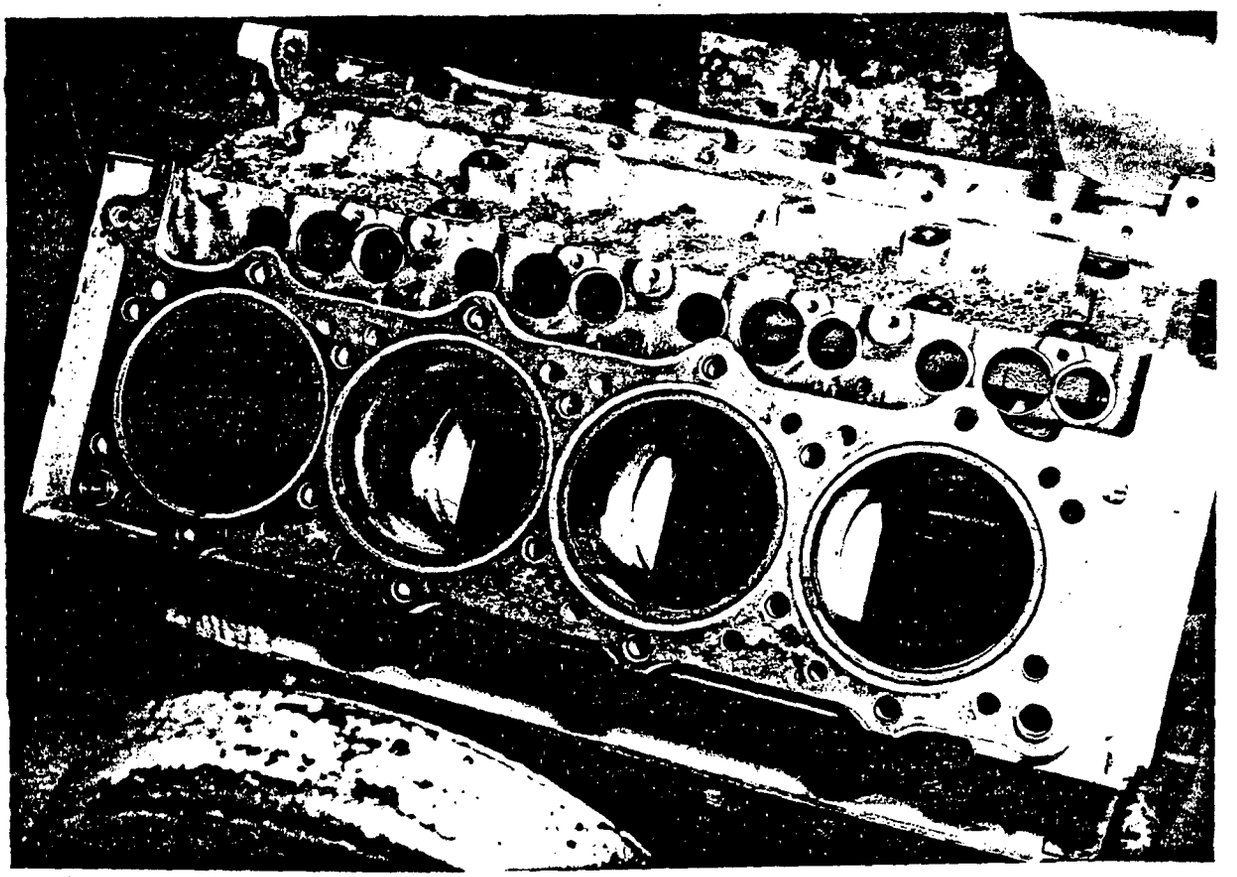


TEST SETUP - LEFT SIDE

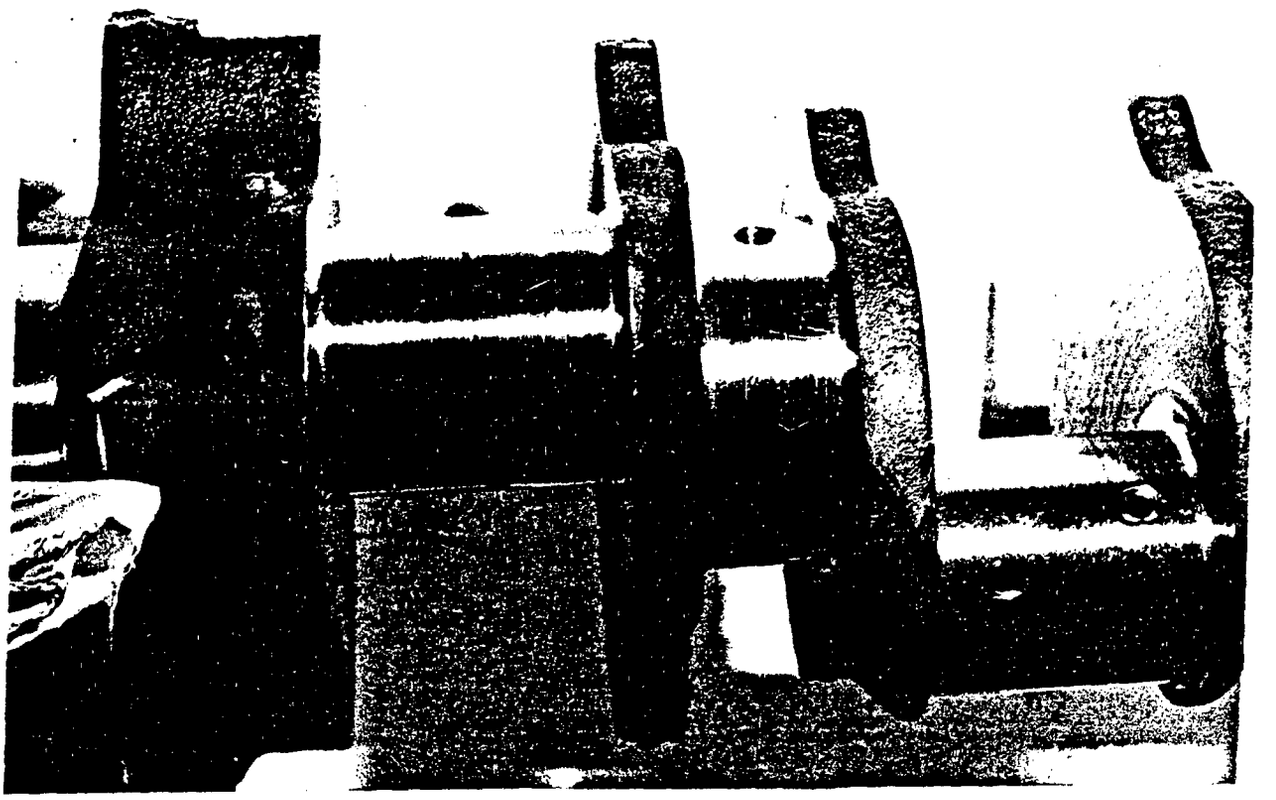




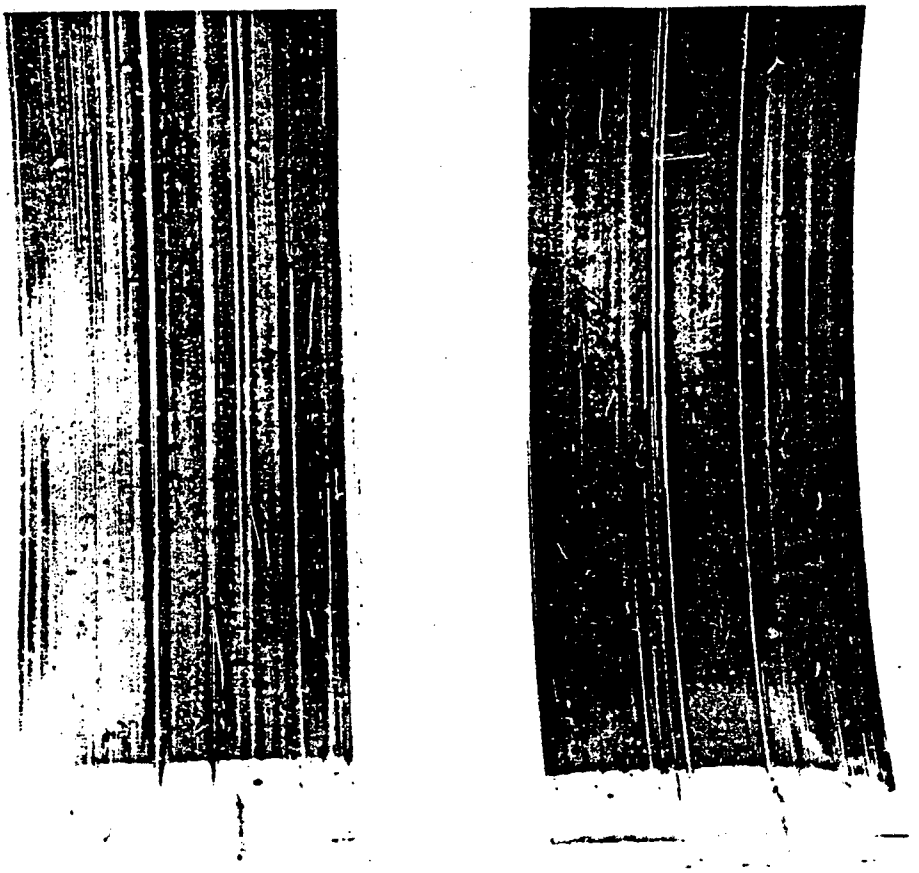
CYLINDERS - SATISFACTORY CONDITION



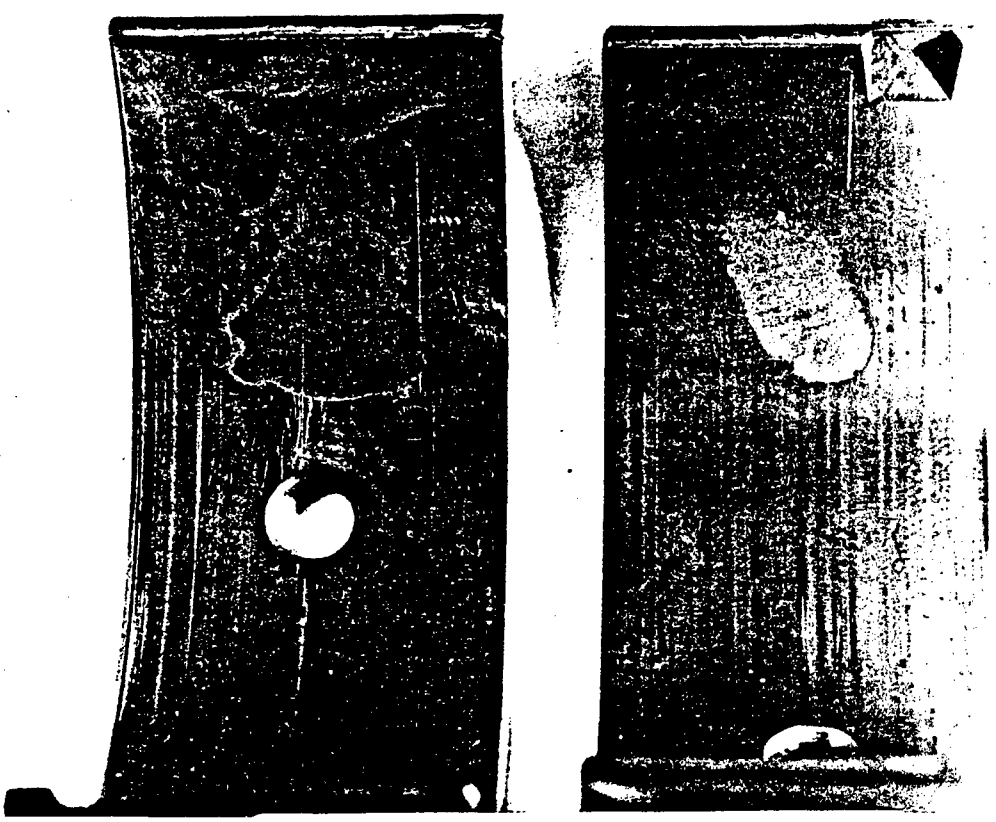
CYLINDERS - SATISFACTORY CONDITION



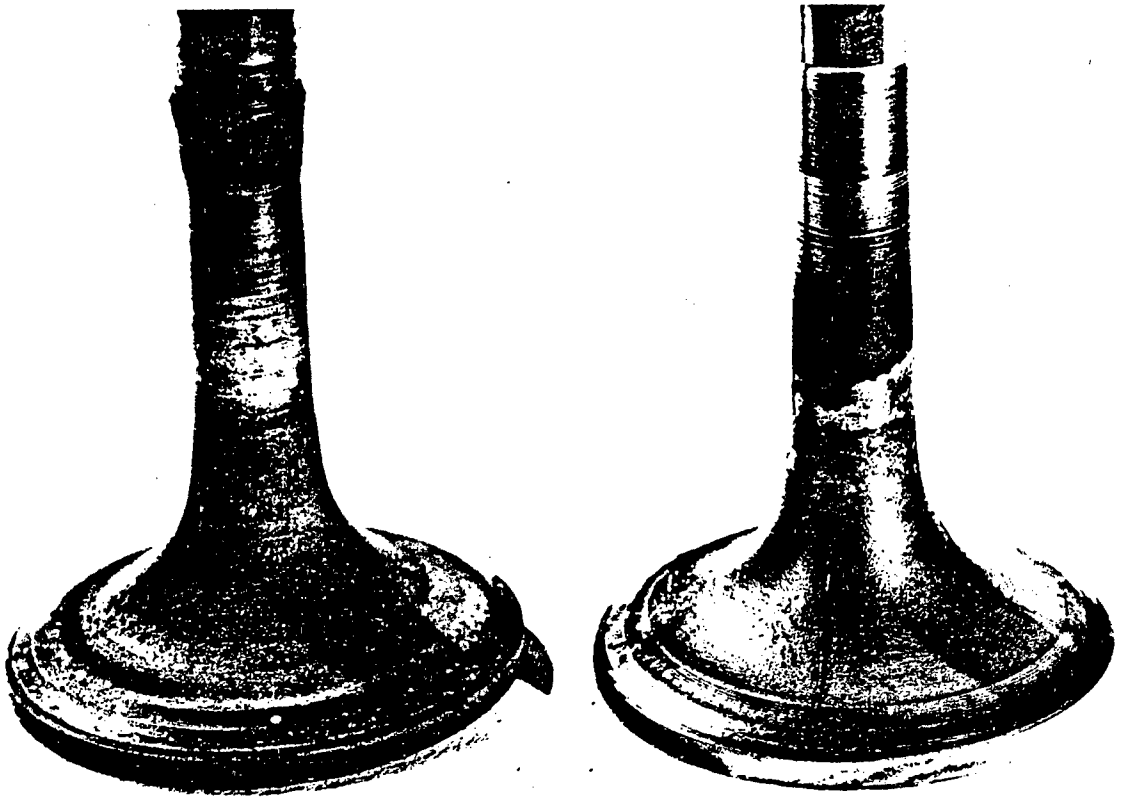
MAIN AND ROD JOURNALS - SATISFACTORY CONDITION



MAIN BEARINGS - SATISFACTORY CONDITION



ROD BEARINGS - SATISFACTORY CONDITION



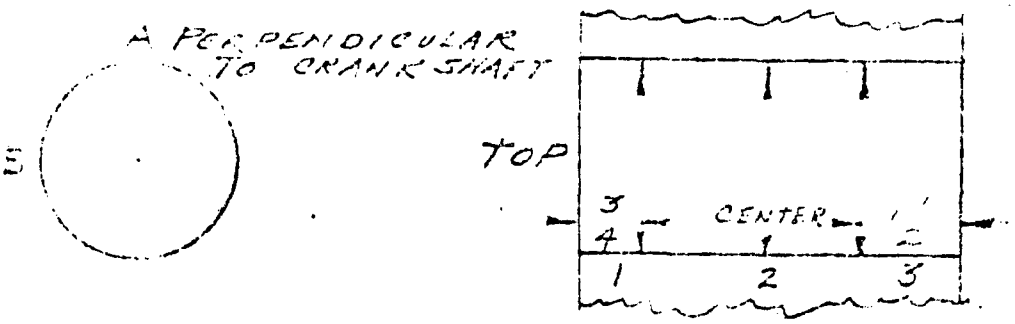
INTAKE AND EXHAUST VALVES - SATISFACTORY CONDITION

APPENDIX G

DIMENSIONAL INSPECTION SHEETS

CYLINDER LINER BORES

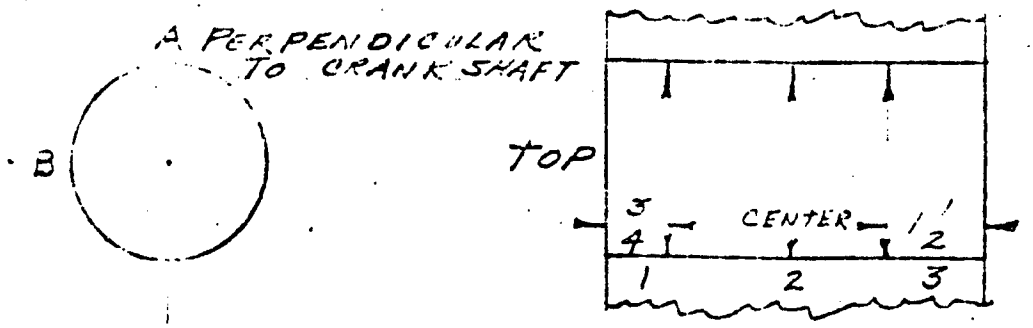
DATE	SHEET
ENGINE NO VT-504	SERIAL
RECORDED BY DRSTA-QAA	CHECKED BY



CYL NO.	LOC	POSITION 1	2	3	TAPER	REMARKS
1	A	4.6250	4.6242	4.6223		
	B	4.6240	4.6246	4.6244		
	OR					
2	A	4.6258	4.6253	4.6241		
	B	4.625	4.6254	4.6253		
	OR					
3	A	4.6251	4.6246	4.6238		
	B	4.6251	4.6255	4.6253		
	OR					
4	A	4.6254	4.6255	4.6249		
	B	4.6256	4.6255	4.6255		
	OR					
	A					
	B					
	OR					
	A					
	B					
	OR					

CYLINDER LINER BORES

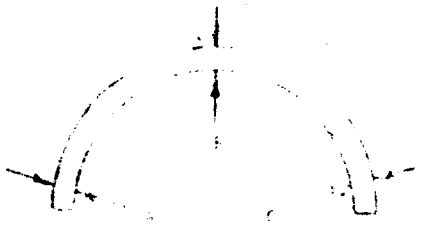
DATE	SHEET OF
ENGINE NO VT-504	SERIAL NO.
RECORDED BY DRSTA-QAA	CHECKED BY



CYL NO.	LOC.	POSITION 1	2	3	TAPER	REMARKS
5	A	4.6262	4.6258	4.6246		
	B	4.6262	4.6258	4.6256		
	OR					
6	A	4.6254	4.6254	4.6236		
	B	4.6244	4.6246	4.6242		
	OR					
7	A	4.6259	4.6255	4.6244		
	B	4.6251	4.6253	4.6249		
	OR					
8	A	4.6261	4.6258	4.6242		
	B	4.6248	4.6248	4.6242		
	OR					
	A					
	B					
	OR					
	A					
	B					
	OR					

MAIN BEARING SHELL THICKNESS
(LAB. SOP.)

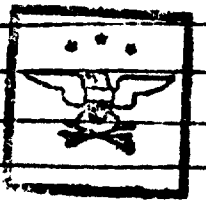
DATE	SHEET 1 OF 1
10/30/82	
ENGINE NO. VT-504	WORK
RECORDED BY DRSTA-QAA	CHECKED BY MELANSHEK



BRG. NO.	LOC.	UPPER HALF				BRG. NO.	LOC.	LOWER HALF			
		FRONT	REAR	TAPER	WEAR			FRONT	REAR	TAPER	WEAR
1	A	.1242	.1242	.0		1	A	.1242	.1242	.0	
	B	.1250	.1248	.0002			B	.1250	.1250	.0	
	C	.1230	.1225	.0005			C	.1245	.1235	.0010	
2	A	.1240	.1241	.0001		2	A	.1238	.1242	.0004	
	B	.1252	.1251	.0001			B	.1247	.1247	.0	
	C	.1243	.1242	.0001			C	.1245	.1240	.0005	
3	A	.1239	.1248	.0009		3	A	.1228	.1240	.0012	
	B	.1250	.1250	.0			B	.1249	.1247	.0002	
	C	.1242	.1232	.0010			C	.1243	.1242	.0001	
4	A	.1242	.1245	.0003		4	A	.1237	.1247	.0010	
	B	.1250	.1250	.0			B	.1248	.1247	.0010	
	C	.1245	.1245	.0			C	.1239	.1240	.0001	
5	A	.1242	.1242	.0		5	A	.1239	.1240	.0001	
	B	.1250	.1250	.0			B	.1249	.1248	.0001	
	C	.1240	.1242	.0002			C	.1246	.1245	.0001	
	A						A				
	B						B				
	C						C				
	A						A				
	B						B				
	C						C				

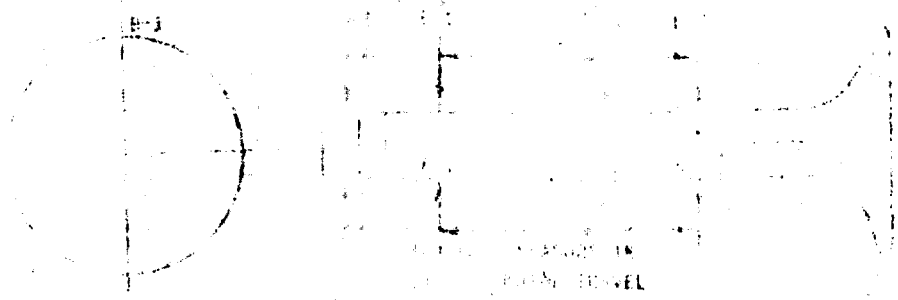
REMARKS:

INSPECTED



ARSENAL
MICHIGAN

DATE	SHEET 1 OF 2
10/30/82	
ENGINE	WORK ORDER
VT-504	
RECEIVED BY	CHECKED BY
DRSTA-QAA	G. FURTON



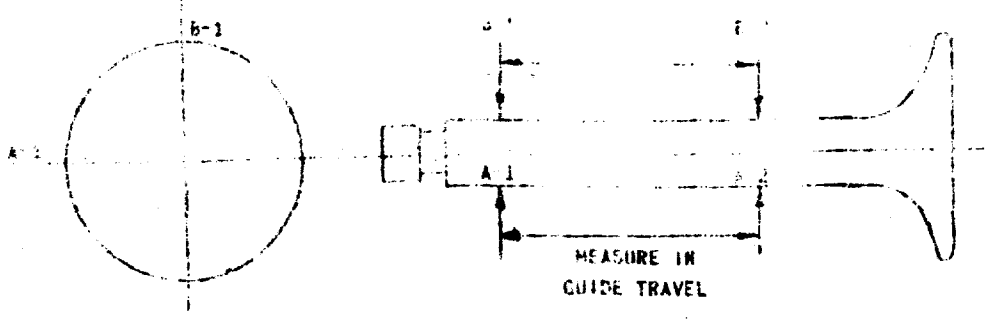
CYL. NO.		POSITION 1	POSITION 2	TAKEN
A EXH. #1		.3789	.3788	.0006
		.3786	.3786	.0002
R.B.		.0001	.0003	
INT. #1		.379	.379	.000
		.379	.3789	.0001
R.B.		.0	.0001	
B EXH. #1		.379	.3785	.0005
		.379	.3785	.0005
R.B.		.0000	.001	
INT. #1		.379	.3788	.0002
		.3789	.3786	.0003
R.B.			.0	.0002
C EXH. #1		.3789	.3788	.0001
		.3789	.3788	.0001
L.B.		.0	.0	
INT. #1		.3789	.3785	.0004
		.3789	.3785	.0004
L.B.				
C EXH. #2		.3789	.3789	.0
		.3789	.3788	.0001
L.B.		.0	.0001	
D INT. #2		.3789	.3785	.0004
		.3788	.3772	.0016
L.B.		.0001	.0013	
A EXH. #2		.379	.379	.0
		.3789	.3789	.0
R.B.		.0001	.0001	
D INT. #2		.3788	.3786	.0002
		.3788	.3787	.0001
L.B.		.0	.0001	
A EXH. #2		.3789	.3789	.0
		.3789	.3789	.0
R.B.		.0	.0	
D INT. #2		.3788	.3789	.0001
		.3788	.3788	.0
L.B.		.0	.0001	

CYL. NO.		POSITION 1	POSITION 2	TAKEN
B EXH. #2	A	.379	.3789	.0001
	B	.379	.3787	.0002
L.B.		.0000	.0002	
B INT. #2	A			
	B			
B EXH. #2	A	.3788	.3785	.0000
	B	.379	.3786	.0000
L.B.		.0001	.0	
C INT. #2	A			
	B			
C EXH. #2	A	.3789	.3786	.0001
	B	.3788	.3788	.0000
L.B.		.0001	.0000	
C INT. #2	A			
	B			
C EXH. #2	A	.3789	.379	.0001
	B	.3786	.3786	.0001
L.B.		.0003	.0003	
D INT. #3	A	.3789	.3782	.0007
	B	.379	.3785	.0005
R.B.		.0001	.0003	
E EXH. #3	A	.379	.376	.003
	B	.379	.376	.003
L.B.		.0	.0	
D INT. #3	A	.3788	.3787	.0001
	B	.3788	.3782	.0006
R.B.		.0	.0005	
E EXH. #3	A	.379	.376	.003
	B	.379	.3759	.0031
L.B.		.0	.0001	
F INT. #3	A	.3987	.3987	.0
	B	.3987	.3987	.0
L.B.		.0	.0	

DATE 10/30/82	SHEET 2 OF 2
ENGINE NO. VT-504	FORK OPERATED
RECORDED BY DRSTA-QAA	CHECKED BY G. FURTON

INTAKE VALVE STEM DIMENSIONS

(AB SOP)

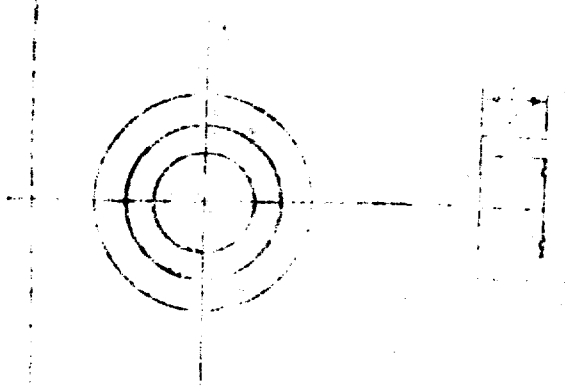


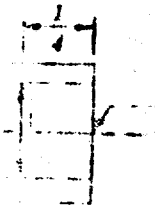
CYL. NO.	LOC.	POSITION 1	POSITION 2	TAPER
G EXH. #3 R.B.	A	.379	.380	.001
	B	.379	.3792	.0002
	OR	.0	.0008	.0008
F INT. #3 L.B.	A	.3789	.3788	.0001
	B	.3789	.3788	.0001
	OR	.0	.0	.0
G EXH. #3 R.B.	A	.379	.379	.0
	B	.379	.379	.0
	OR	.0	.0	
H INT. #4 R.B.	A	.379	.379	.0
	B	.379	.379	.0
	OR	.0	.0	
H EXH. #4 R.B.	A	.3789	.3789	.0
	B	.3789	.3789	.0
	OR	.0	.0	
H INT. #4 R.B.	A	.379	.379	.0
	B	.379	.379	.0
	OR	.0	.0	
H EXH. #4 R.B.	A	.3788	.3782	.0004
	B	.379	.3782	.0007
	OR	.0001	.0000	
I INT. #4 L.B.	A	.3789	.3789	.0
	B	.3789	.3789	.0
	OR	.0	.0	
I EXH. #4 L.B.	A	.379	.3783	.0006
	B	.379	.3785	.0004
	OR	.0	.0002	
I INT. #4 L.B.	A	.3789	.3784	.0005
	B	.3788	.3787	.0001
	OR	.0001	.0003	
I EXH. #4 L.B.	A	.3789	.3784	.0005
	B	.379	.3786	.0004
	OR	.0001	.0002	
INT. #	A			
	B			
	OR			

CYL. NO.	LOC.	POSITION 1	POSITION 2	TAPER
EXH. #	A			
	B			
	OR			
INT. #	A			
	B			
	OR			
EXH. #	A			
	B			
	OR			
INT. #	A			
	B			
	OR			
EXH. #	A			
	B			
	OR			
INT. #	A			
	B			
	OR			
EXH. #	A			
	B			
	OR			
INT. #	A			
	B			
	OR			

DATE 10/30/82	SHEET OF
ENGINE VT-504	WORK ORDER
DRSTA-QAA	CHECKED BY N. O'HARA

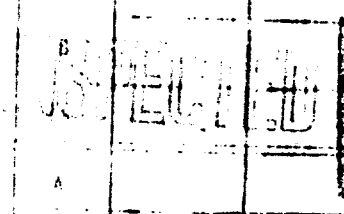
INTAKE VALVE GUIDE BORE DIMENSIONS
(LEFT BOP)





LEFT

CYL. NO.	LOC.	POSITION 1	POSITION 2	SPEC.	CYL. NO.	LOC.	POSITION 1	POSITION 2	SPEC.
1	A	.3824	.3873	.0049	4	A	.3813	.3832	.0019
	B	.3822	.3871	.0049		B	.3824	.3824	.0000
	A	.0002	.0002			A	.0011	.0008	
1	A	.3821	.3904	.0083	4	A	.3821	.3916	.0095
	B	.3818	.3911	.0093		B	.3822	.3906	.0084
	OR	.0003	.0007			A	.0001	.0010	
2	A	.3819	.3841	.0022					
	B	.3821	.3842	.0021					
	OR	.0002	.0001						
2	A	.3819	.3839	.002					
	B	.3818	.384	.0022					
	OR	.0001	.0001						
3	A	.3811	.3816	.0005					
	B	.3812	.3817	.0005					
	OR	.0001	.0001						
3	A	.3812	.3816	.0004					
	B	.3811	.3815	.0004					
	OR	.0001	.0001						

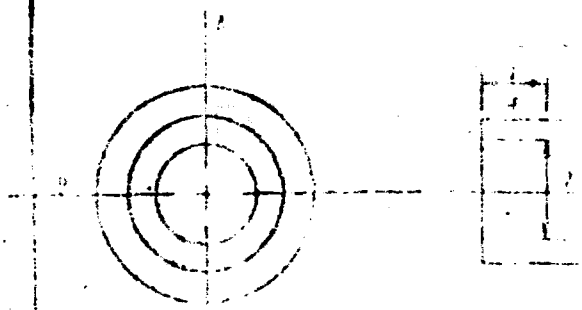


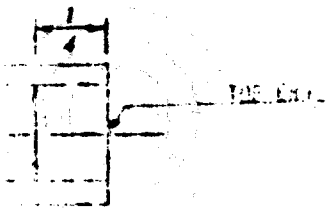
TAC FORM 22 JUL 4533 C

DETROIT ARSENAL

INTAKE VALVE GUIDE BORE DIMENSIONS
(CAP OFF)

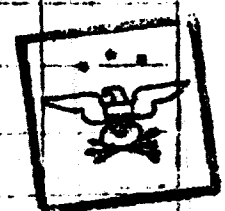
DATE 10/30/82	SHEET OF
ENGINE NO. VT-504	WORK ORDER
DRSTA-QAA	CHECKED BY N. O'HARA





LEFT EXHAUST

POSITION					POSITION		
			BUTTON 2			BUTTON 2	
1	A	.382	.3812	.0008	.3821	.3828	.0007
	B	.3819	.381	.0009	.3823	.3826	.0003
	OR	.0001	.0002		.0002	.0002	
1	A	.382	.381	.001	.3818	.3822	.0004
	B	.382	.3813	.0007	.382	.3819	.0001
	OR	.0000	.0003		.0002	.0003	
2	A	.3821	.3826	.0005			
	B	.382	.3826	.0006			
	OR	.0001	.0000				
2	A	.3819	.3817	.0002			
	B	.3818	.3819	.0001			
	OR	.0001	.0002				
3	A	.382	.3817	.0002			
	B	.3819	.3814				
	OR	.0001	.0001				
3	A	.3823	.382	.0003			
	B	.3822	.3814	.0006			
	OR	.0001	.0006				



EXHAUST &

DATE 10/30/82

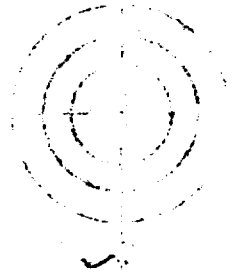
SHEET OF

VT-504

WORK ORDER

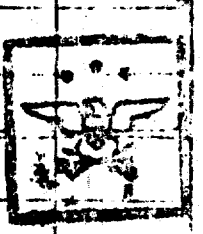
DRSTA-QAA

CHECKED BY N. O'HARA



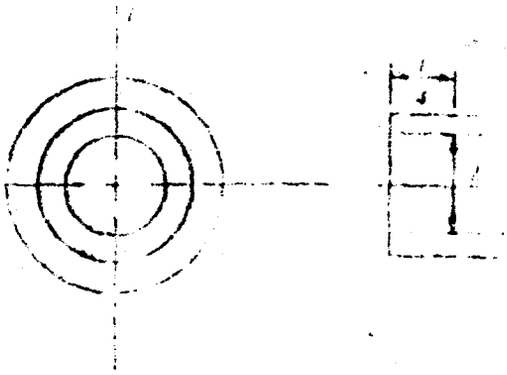
RIGHT EXHAUST

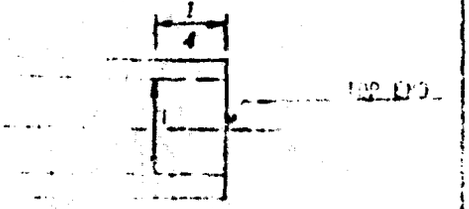
	A	.3819	.3834	.0015		.382	.3813	.0007
1	B	.382	.3836	.0016	4	.382	.3817	.0003
	OR	.0001	.0002			.0000	.0004	
	A	.3818	.3812	.0006		.3819	.382	.0001
1	B	.3818	.382	.0002	4	.3819	.3822	.0003
	OR	.0000	.0008			.0000	.0002	
	A	.3821	.3822	.0001				
2	B	.382	.3821	.0001				
	OR	.0001	.0001					
	A	.3819	.3828	.0009				
2	B	.3818	.382	.0002				
	OR	.0001	.0008					
	A	.3819	.3817	.0002				
3	B	.3819	.3811	.0008				
	OR	.0000	.0006					
	A	.3818	.3817	.0001				
3	B	.3819	.3817	.0002				
	OR	.0001	.0000					



INTAKE VALVE GUIDE BORE DIMENSIONS
(OF)

DATE	SHEET OF
10/30/82	
ENGINE NO. VT-504	WORK ORDER
INSPECTED BY DRSTA-QAA	CHECKED BY N. O'HARA



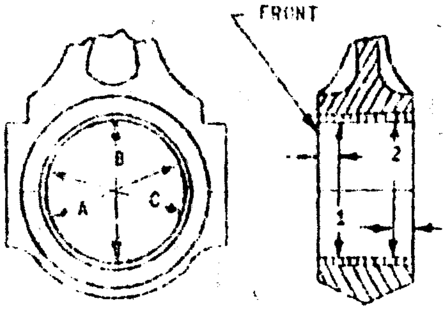


RIGHT

							POSITION 2	
1	A	.3812	.3836	.0024	4	.3812	.3822	.001
	B	.3811	.3834	.0023		.3812	.3818	.0006
	OR	.0001	.0002			.0000	.0004	
1	A	.3811	.3824	.0013	4	.3812	.3845	.0033
	B	.3812	.3821	.0009		.3811	.3866	.0055
	OR	.0001	.0003			.0001	.0021	
2	A	.381	.3842	.0032				
	B	.3811	.3842	.0031				
	OR	.0001	.0000					
2	A	.3809	.3842	.0033				
	B	.381	.384	.003				
	OR	.0001	.0002					
3	A	.3813	.382	.0007				
	B	.3813	.3822	.0008				
	OR	.0000	.0002					
3	A	.3821	.3819	.0002	A			
	B	.3822	.3807	.0015				
	OR	.0001	.0012					

DATE 10/30/82	SHEET 1 OF 1
ENGINE NO. VT-504	LWO NO.
RECORDED BY DRSTA-QAA	CHECKED BY R. MELANSHEK

CONNECTING ROD BEARINGS



BEARING		SPEC. BEARING I.D. 1	2	TAPER	AVG. DIA.
L1	A	2.5025	2.5025	.0	
	B	2.5025	2.5025	.0	
	C	2.5028	2.5025	.0003	----
	OR	0.0003	0.0000	.0003	
L2	A	2.5030	2.5028	.0002	
	B	2.5028	2.5028	.0	
	C	2.5023	2.5023	.0	----
	OR	0.0007	0.0005	.0002	
L3	A	2.5026	2.5026	.0	
	B	2.5028	2.5026	.0002	
	C	2.5025	2.5026	.0001	----
	OR	0.0003	0.0000	.0003	
L4	A	2.5023	2.5023	.0	
	B	2.5023	2.5023	.0	
	C	2.5026	2.5026	.0	----
	OR	0.0003	0.0003	.0	
R1	A	2.5030	2.5030	.0	
	B	2.5030	2.5030	.0	
	C	2.5025	2.5025	.0	----
	OR	0.0005	0.0005	.0	
R2	A	2.5028	2.5028	.0	
	B	2.5028	2.5028	.0	
	C	2.5024	2.5022	.0002	----
	OR	0.0004	0.0006	.0002	
R3	A	2.5023	2.5021	.0002	
	B	2.5021	2.5028	.0007	
	C	2.5028	2.5028	.0	----
	OR	0.0005	0.0007	.0002	
R4	A	2.5028	2.5030	.0002	
	B	2.5027	2.5031	.0004	
	C	2.5025	2.5025	.0	
	OR	0.0003	0.0006	.0003	
	A				
	B				
	C				----
	OR				
	A				
	B				
	C				----
	OR				

BEARING	SPEC. BEARING I.D. 1	2	TAPER	AVG. DIA.
A				
B				
C				----
OR				
A				
B				
C				----
OR				
A				
B				
C				----
OR				
A				
B				
C				----
OR				
A				
B				
C				----
OR				
A				
B				
C				----
OR				
A				
B				
C				----
OR				
A				
B				
C				----
OR				
A				
B				
C				----
OR				
A				
B				
C				----
OR				

INSPECTED

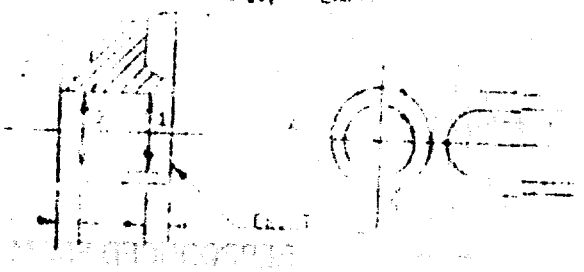
DAR FORM 1910-B 12 JUN 58

DETROIT ARSENAL
CENTER LINE, MICHIGAN

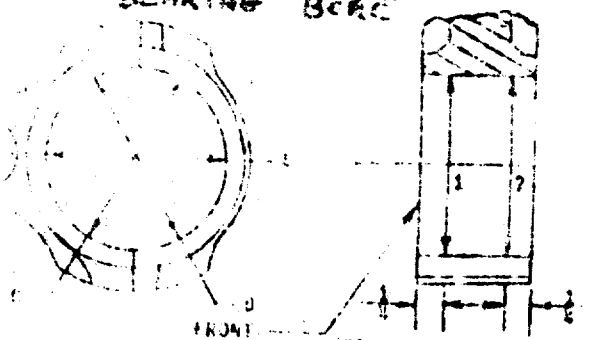
CONNECTING ROD
PIN BORE & BEARING BORE

DATE	SHEET
11/1/82	1 OF 1
ENGINE NO.	WORK ORDER
VT-504	
RECORDED BY	CHECKED BY
DRSTA-QAA	R. MELANSHEK

PIN BORE



BEARING BORE



PIN BORE

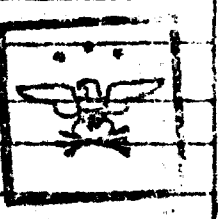
		1	2	TAPER	AVG. DIA.
		1.3762	1.3762	.0	
1L		1.3761	1.3761	.0	
		0.0001	0.0001	.0	
		1.3761	1.3761	.0	
2L		1.3761	1.3761	.0	
		0.0000	0.0000	.0	
		1.3761	1.3761	.0	
3L		1.3761	1.3761	.0	
		0.0000	0.0000	.0	
		1.3761	1.3761	.0	
4L		1.3762	1.3761	.0	
		0.0001	0.0000	.0001	
		1.3762	1.3762	.0	
1R		1.3762	1.3762	.0	
		0.0000	0.0000	.0	
		1.3762	1.3762	.0	
2R		1.3762	1.3762	.0	
		0.0000	0.0000	.0	
		1.3762	1.3762	.0	
3R		1.3762	1.3761	.0001	
		0.0000	0.0001	.0001	
		1.3762	1.3762	.0	
4R		1.3762	1.3762	.0	
		0.0000	0.0000	.0	

BEARING BORE

		BORE DIA. POSITION 1	2	TAPER
1L	A	2.6908	2.6908	.0
	B	2.6906	2.6906	.0
		2.6908	2.6908	.0
		0.0002	0.0002	.0
2L		2.6910	2.6910	.0
		2.6912	2.6912	.0
		2.6900	2.6900	.0
		0.0012	0.0012	.0
3L		2.6910	2.6912	.0002
		2.6912	2.6912	.0
		2.6905	2.6908	.0003
		0.0007	0.0004	.0003
4L		2.6905	2.6905	.0
		2.6910	2.6910	.0
		2.6900	2.6900	.0
		0.0010	0.0010	.0
1R		2.6910	2.6910	.0
		2.6912	2.6911	.0001
		2.6910	2.6910	.0
		0.0002	0.0001	.0001
2R		2.6910	2.6908	.0002
		2.6907	2.6907	.0
		2.6906	2.6907	.0001
		0.0004	0.0001	.0003
3R		2.6912	2.6912	.0
		2.6910	2.6910	.0
		2.6910	2.6910	.0
		0.0002	0.0002	.0
4R		2.6905	2.6905	.0
		2.6910	2.6910	.0
		2.6900	2.6900	.0
		0.0010	0.0010	.0

DATE	SHEET 2 OF 2
10/30/82	
ENGINE NO. VT-504	WORK [illegible]
RECORDED BY DRSTA-QAA	CHECKED BY R. MELANSHEK

CONN. ROD NO.	LOC.	UPPER BEARING FRONT	UPPER BEARING REAR	UPPER BEARING TAPER	UPPER BEARING WEAR	LOWER BEARING FRONT	LOWER BEARING REAR	LOWER BEARING TAPER	LOWER BEARING WEAR
		.0935	.0937	.0002		A .0936	.0938	.0002	
L1		.0944	.0940	.0001		L1 B .0941	.0942	.0001	
		.0937	.0937	.0		C .0940	.0938	.0002	
	A	.0938	.0938	.0		A .0935	.0938	.0003	
L2	B	.0942	.0942	.0		L2 B .0942	.0942	.0	
		.0939	.0937	.0002		C .0938	.0935	.0003	
		.0935	.0938	.0003		A .0936	.0938	.0002	
L3		.0940	.0941	.0001		L3 B .0943	.0942	.0001	
		.0935	.0935	.0		C .0937	.0938	.0001	
		.0937	.0938	.0001		A .0935	.0939	.0004	
L4		.0940	.0938	.0002		L4 B .0944	.0942	.0002	
	C	.0942	.0938	.0004		C .0938	.0938	.0	
						A			
	B					B			
						C			
	A					A			
	B					B			
						C			



	DATE	SHEET
b. CONNECTING ROD BEARING SHELL THICKNESS	10/30/82	1 OF 2
	ENGINE NO. VT-504	WORK ORDER
	RECORDED BY DRSTA-QAA	CHECKED BY R. MELANSHEK

UPPER HALF						LOWER HALF					
ROD NO.	LOC.	FRONT	REAR	TAPER	WEAR	CONN. ROD NO.	LOC.	FRONT	REAR	TAPER	WEAR
	A	.0938	.0940	.0002			A	.0938	.0939	.0001	
R1	B	.0938	.0942	.0004		R1	B	.0943	.0944	.0001	
	C	.0937	.0938	.0001			C	.0940	.0939	.0001	
	A	.0940	.0940	.0			A	.0938	.0939	.0001	
R2	B	.0943	.0942	.0001		R2	B	.0942	.0942	.0	
	C	.0938	.0940	.0002			C	.0940	.0940	.0	
	A	.0938	.0938	.0			A	.0935	.0933	.0002	
R3	B	.0940	.0942	.0002		R3	B	.0940	.0935	.0005	
	C	.0933	.0933	.0			C	.0938	.0938	.0	
	A	.0936	.0937	.0001			A	.0935	.0939	.0004	
R4	B	.0942	.0938	.0004		R4	B	.0940	.0942	.0002	
	C	.0938	.0940	.0002			C	.0933	.0935	.0002	
	A						A				
	B						B				
	C						C				
	A						A				
	B						B				
	C						C				

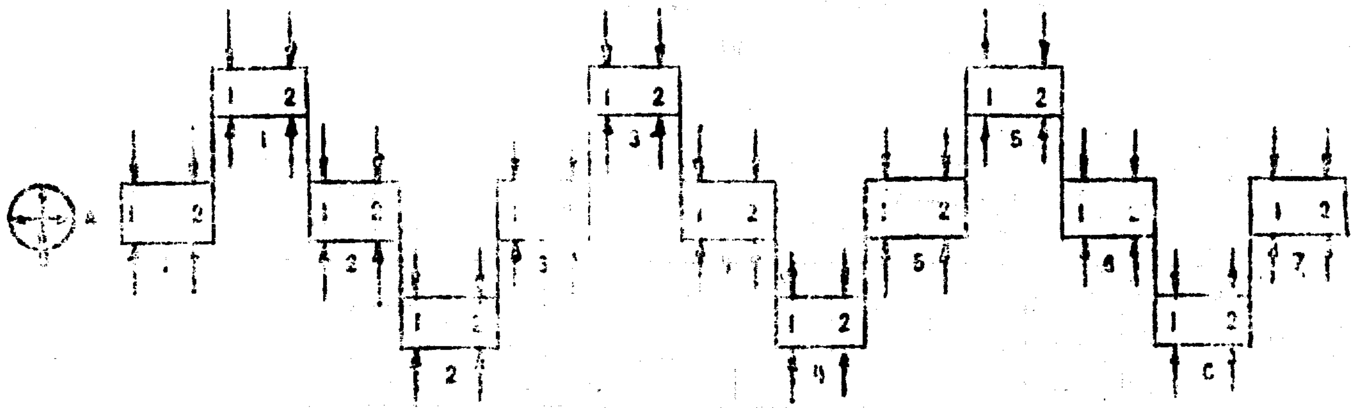
REMARKS

INSPECTED

g.

CRANKSHAFT JOURNAL AND CRANKPIN DIAMETERS
(LAB. TOP.)

DATE	SHEET OF
10/30/82	
ENGINE NO.	WORK ORDER
VT-504	
RECORDED BY	CHECKED BY
DRSTA-QAA	G. FURTON



NOTE: Crankpin #1 is in vertical position

JOURNAL		MAIN JOURNAL DIAMETERS				CRANKPIN		CRANKPIN DIAMETERS			
NO.	LOC.	1	2	TAPER	WEAR	NO.	LOC.	1	2	TAPER	WEAR
1	A	3.5001	3.4999	.0002			A	2.4996	2.4995	.0001	
	B	3.500	3.500	0			B	2.4995	2.4994	.0001	
	O-R	.0001	.0001	.0002			O-R	.0001	.0001	.0002	
1	A	2.4994	2.499	.0004			A				
	B	2.4993	2.4991	.0002			B				
	O-R	.0001	.0001	.0004			O-R				
2	A	3.4998	3.4999	.0001			A				
	B	3.4998	3.4997	.0001			B				
	O-R	0	.0002	.0002			O-R				
2	A	2.4994	2.4993	.0001			A				
	B	2.4991	2.4992	.0001			B				
	O-R	.0003	.0001	.0002			O-R				
3	A	3.4998	3.4994	.0004			A				
	B	3.4996	3.4995	.0001			B				
	O-R	.0002	.0001	.0001			O-R				
3	A	2.4993	2.4994	.0001			A				
	B	2.4993	2.4993	0			B				
	O-R	0	.0001	.0001			O-R				
4	A	3.4996	3.4995	.0001			A				
	B	3.4995	3.4995	0			B				
	O-R	.0001	0	.0001			O-R				

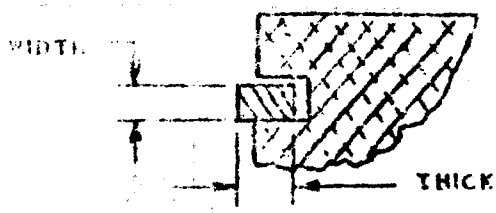
INSPECTED

TAC FORM 4532

DETROIT ARSENAL
CENTER LINE, MICHIGAN

PISTON RING THICKNESS AND WIDTH

DATE	SHEET OF
10/30/82	
ENGINE NO. VT-504	WORK ORDER NO.
RECORDED BY DRSTA-QAA	CHECKED BY G. GREMBOS



CYL. NO.		THICKNESS RING NO.						WIDTH RING NO.					
		TOP	2	3	4	5	6	TOP	2	3	4	5	6
L1	MAX	.186	.186	.126				.115	.0935	.109			
	MIN	.184	.184	.125				.115	.0935	.1085			
L2	MAX	.181	.190	.124				.1148	.0935	.109			
	MIN.	.180	.183	.123				.1145	.0935	.1085			
L3	MAX.	.183	.189	.125				.115	.0935	.1085			
	MIN.	.180	.187	.124				.115	.0930	.1085			
L4	MAX.	.181	.187	.125				.115	.0935	.109			
	MIN.	.180	.186	.124				.115	.0930	.1085			
	MAX.												
	MIN												
R1	MAX	.182	.187	.125				.115	.0935	.1085			
	MIN.	.181	.185	.124				.115	.0935	.1085			
R2	MAX.	.187	.183	.125				.1145	.0935	.1085			
	MIN	.184	.181	.125				.1145	.0935	.1085			
R3	MAX.	.184	.187	.125				.115	.0935	.1085			
	MIN.	.183	.184	.125				.115	.0935	.1085			
R4	MAX.	.185	.184	.125				.115	.0935	.109			
	MIN.	.182	.180	.124				.1145	.0935	.1085			
	MAX.												
	MIN.												
	MAX.												
	MIN.												
	MAX.												
	MIN.												

INSPECTED

TAC FORM 4534 F
22 JUL 80

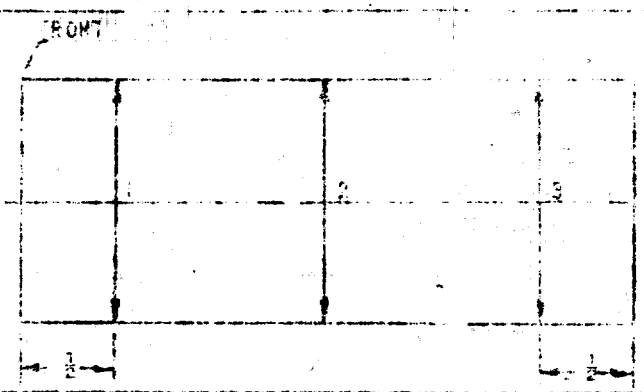
DATE: 10/30/82

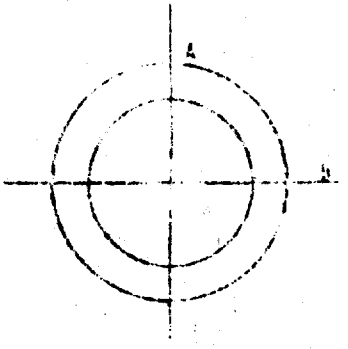
SHEET OF

ENGINE NO.: VT-504

REQUESTED BY: DRSTA-CAA

INSPECTED BY: G. FURTON

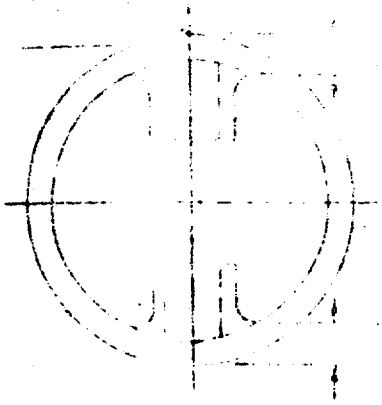


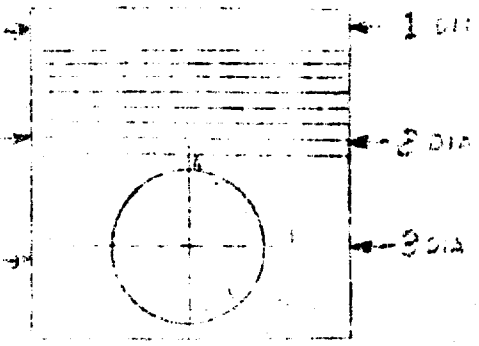


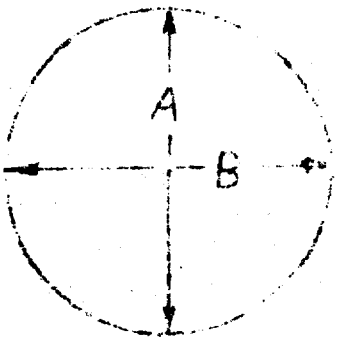
CYL. NO.	LOC	POSITION 1	POSITION 2	POSITION 3	TAPER	AVG. WEAR	CYL. NO.	LOC	POSITION 1	POSITION 2	POSITION 3	TAPER	AVG. WEAR
	A1	1.3741	1.3740	1.3741	.0001	.0001		A1					
R1	B1	1.3741	1.3740	1.3741	.0001	.0001		B1					
	OR	0	0	0				OR					
	A2	1.3742	1.3741	1.3742	.0001	.0001		A2					
R2	B2	1.3742	1.3740	1.3742	.0002	.0002		B2					
	OR	0	.0001	0	.0001	.0001		OR					
	A3	1.3742	1.3742	1.3742	.0000	.0000		A3					
R3	B3	1.3743	1.3742	1.3743	.0001	.0001		B3					
	OR	.0001	.0000	.0001				OR					
	A1	1.3743	1.3741	1.3742	.0001	.0001		A1					
R4	B1	1.3742	1.3741	1.3742	.0001	.0001		B1					
	OR	0	0	0				OR					
	A2							A2					
	B2							B2					
	OR							OR					
	A3	1.3741	1.3741	1.3741	.0001	.0001		A3					
L1	B3	1.3741	1.3741	1.3742	.0001	.0001		B3					
	OR	0	.0001	.0001				OR					
	A1	1.3742	1.3741	1.3742	.0001	.0001		A1					
L2	B1	1.3742	1.3741	1.3743	.0002	.0002		B1					
	OR	0	0	.0001	.0001	.0001		OR					
	A2	1.3742	1.3741	1.3741	.0001	.0001		A2					
	B2	1.3742	1.3741	1.3742	.0001	.0001		B2					
	OR	0	0	.0001				OR					
	A3	1.3743	1.3742	1.3743	.0001	.0001		A3					
L4	B3	1.3743	1.3741	1.3743	.0002	.0002		B3					
	OR	0	.0001	0	.0001	.0001		OR					

INSPECTED

	DATE 10/30/82		SHEET 07
	TEST NO. VT-504		WORK ORDER
	RECORDED BY DRSTA-QAA		CHECKED BY G. GREMBOS







	PISTON DIA	BORE	TAPER	AVG DIA	PISTON OD	1 DIA	2 DIA	3 DIA
L1	A1 1.3746	A2 1.3746	.0000		A	4.587	A 4.605	A 4.615
	B1 1.3746	B2 1.3746	.0000		B	4.586	B 4.605	B 4.615
	OR .0000	OR .0000	.0000	1.3746	OR	.001	OR .000	OR .000
L2	A1 1.3746	A2 1.3746	.0000		A	4.586	A 4.608	A 4.615
	B1 1.3746	B2 1.3746	.0000		B	4.586	A 4.608	B 4.615
	OR .0000	OR .0000	.0000	1.3746	OR	.000	OR .000	OR .000
L3	A1 1.3744	A2 1.3744	.0000		A	4.587	A 4.606	A 4.616
	B1 1.3744	B2 1.3744	.0000		B	4.590	B 4.605	B 4.616
	OR .0000	OR .0000	.0000	1.3744	OR	.003	OR .001	OR .000
L4	A1 1.3744	A2 1.3744	.0000		A	4.588	A 4.605	A 4.616
	B1 1.3744	B2 1.3744	.0000		B	4.587	B 4.605	B 4.616
	OR .0000	OR .0000	.0000	1.3744	OR	.001	OR .000	OR .000
	A1	A2			A		A	A
	B1	B2			B		B	B
	OR	OR			OR		OR	OR
R1	A1 1.3744	A2 1.3744	.0000		A	4.591	A 4.605	A 4.615
	B1 1.3744	B2 1.3744	.0000		B	4.590	B 4.605	B 4.615
	OR .0000	OR .0000	.0000	1.3744	OR	.001	OR .000	OR .000
R2	A1 1.3744	A2 1.3744	.0000		A	4.590	A 4.605	A 4.615
	B1 1.3744	B2 1.3744	.0000		B	4.588	B 4.606	B 4.615
	OR .0000	OR .0000	.0000	1.3744	OR	.002	OR .001	OR .000
R3	A1 1.3744	A2 1.3744	.0000		A	4.588	A 4.605	A 4.615
	B1 1.3744	B2 1.3744	.0000		B	4.588	B 4.606	B 4.615
	OR .0000	OR .0000	.0000	1.3744	OR	.000	OR .001	OR .000
R4	A1 1.3744	A2 1.3744	.0000		A	4.588	A 4.605	A 4.616
	B1 1.3744	B2 1.3744	.0000		B	4.588	B 4.605	B 4.616
	OR .0000	OR .0000	.0000	1.3744	OR	.000	OR .000	OR .000
	A1	A2			A		A	A
	B1	B2			C		B	B
	OR	OR			OR		OR	OR
	A1	A2			A		A	A
	B1	B2			B		C	B
	OR	OR			OR		OR	OR
	A1	A2			A		A	A
	B1	B2			B		B	B
	OR	OR			OR		OR	OR

APPENDIX H

NATO REQUIRED DATA SHEETS

FULL LOADS AT 100-HOUR INTERVALS

PART LOADS AT ENDURANCE COMPLETION

ENGINE Type: Cummins 504 N°:								Place date:	
FULL CHARGE PERFORMANCES INITIAL ☐ FINAL ☐								Reference:	
FUEL:				OIL type:				BRAKE type:	
Volume mass: kg/dm³				grade:				Full Load at 0 Hours	
AMBIENT	t0	°C	21.6	22.2	22.3	22.4	22.3	22.45		
	p0	mbar	996.2	996.2	996.2	996.2	996.2	996.2		
PERFORMANCE	n	r.p.m	1400	1800	1900	2200	2600	3000		
	M	m.daN	576.3	608.8	602	577.6	538.3	541		
	p	kw	84.4	114.9	119.8	132.9	146.5	169.1		
	pme	bar	8.76	9.27	9.16	8.78	8.2	8.2		
FUEL	Cs/bsfc	g/kw h	232.9	224.5	222	220.8	225	226.3		
	Qc	mm³/cycle	69.3	70.67	68.98	65.67	62.4	62.8		
	qm	kg/h	19.68	25.8	26.58	29.3	32.9	38.22		
OIL	tH	°C	104	109.9	110.8	112.4	115.4	118.9		
	pH	bar	2.87	3.42	3.59	4.03	4.4	4.5		
WATER	te	°C	85.6	86.8	87.12	87.8	88.34	88.1		
	ts	°C	93.87	94.22	94.4	94.3	94.35	94.33		
INLET	t1	°C	23.9	24.3	24.4	24.3	24.2	24.3		
	p0 - p1	mbar	1.92	1.93	1.92	1.92	1.99	2.01		
	t2	°C	49.87	62.7	65.3	72.8	83.8	103.0		
	p2	bar	.218	.360	.390	.486	.609.5	.809		
	t2'	°C	49.87	62.7	65.3	72.8	83.8	103.0		
	p2-p2'	mbar	---	---	---	---	---	---		
EXHAUST	t3	°C	544.4	562.25	553.9	535.5	515.1	527.4		
	p3	bar	.089	.176	.199	.285	.425	.644		
	t4	°C	471.3	480.8	475.5	471.8	450.3	447.8		
	p4-p0	mbar	.241	5.43	4.1	8.5	14.4	23.0		
	Smoke	Bosch	---	---	---	---	---	---		
BLOW-BY		cm³/mn	132.2	142.7	153	171.4	194.6	252.8		

ENGINE Type: Cummins 504 N°:									Place date:
FULL CHARGE PERFORMANCES INITIAL ☐ FINAL ☐									Reference:
FUEL:			OIL type:						BRAKE type:
Volume mass: kg/dm³			grade:						Full Load at 100 Hours
AMBI-ENT	t0	°C	24.3	24.25	23.55	23.7	25.3	24.0		
	p0	mbar								
PERFORMANCE	n	r.p.m	1400	1800	1900	2200	2600	3000		
	M	m.daN	589.9	621	617	560	550	550		
	p	kw	86.2	117	122.6	130	157	172.1		
	pme	bar	8.9	9.44	9.38	8.5	8.4	8.33		
FUEL	Cs/bsfc	g/kw h	226	218	218	217.8	220	219.6		
	Qc	mm³/cycle	68.7	69.6	69.3	63.2	62.7	62.1		
	qm	kg/h	19.5	25.4	26.7	28.2	33.1	37.8		
OIL	tH	°C	105.3	110.04	111.2	112.6	116.2	119.2		
	pH	bar	2.83	3.35	3.47	3.96	4.3	4.4		
WATER	te	°C	87.4	87.2	87.9	88.6	88.5	88.5		
	ts	°C	95.9	95.7	95.6	95.5	95.5	95.5		
INLET	t1	°C	24.9	24.8	24.2	24.4	25.4	24.8		
	p0 - p1	mbar	3.5	4.35	5.0	6.2	10.4	13.7		
	t2	°C	51.87	64.9	67.8	74.1	90.6	108.46		
	p2	bar	.225	.373	.418	.490	.663	.867		
	p2'	°C	51.87	64.9	67.8	74.1	90.6	108.46		
	p2-p2'	mbar	---	---	---	---	---	---		
EXHAUST	t3	°C	542	555	551	518	517	527.5		
	p3	bar	.112	.198	.225	.307	.478	.707		
	t4	°C	477.8	480.9	480.5	460.5	450.8	445.1		
	p4-p0	mbar	.625	7.92	7.96	11.8	22.1	37.4		
	Smoke	bosch	---	---	---	---	---	---		
BLOW-BY		cm³/mn	225	257	267	284	372	505		

ENGINE Type: Cummins 504 N°.									Place date:	
FULL CHARGE PERFORMANCES INITIAL ☐ FINAL ☐									Reference:	
FUEL:				OIL type:					BRAKE type:	
Volume mass: kg/dm³				grade:					Full Load at 200 Hours	
AMBIENT	t0	°C	25.4	25.2	25.2	25.03	25.03	24.5		
	p0	mbar	999,2	999.2	999.2	999.2	999.2	999.2		
PERFORMANCES	n	rpm	1400	1800	1900	2200	2600	3000		
	M	mdaN	594	630.5	619.7	574.9	572.2	555.9		
	P	kw	132.5	118.95	123.2	131.7	156.2	175.3		
	pme	bar	9.1	9.5	9.4	8.7	8.52	8.52		
FUEL	Cs/bsfc	g/kw h	225.1	215	214	214	214.7	221.4		
	Qc	mm³/cycle	69.4	69.8	68.2	62.9	63.5	63.7		
	qm	kg/h	19.7	25.5	26.3	28.1	33.5	38.8		
OIL	tH	°C	104.5	109.2	110.1	111.9	114.7	118		
	pH	bar	2.87	3.6	3.8	4.23	4.5	4.5		
WATER	te	°C	86	87.9	88.1	89.1	89.1	89.1		
	ts	°C	94.4	95.5	95.4	95.8	95.4	95.7		
INLET	t1	°C	25.4	25.4	25.3	25.1	25	24.5		
	p0 - p1	mbar	2.82	3.92	4.25	5.38	7.44	9.66		
	t2	°C	52.4	65.8	68.45	74.8	91.5	109.1		
	p2	bar	.231	.378	.413	.494	.682	.880		
	t2'	°C	52.4	65.8	68.45	74.8	91.5	109.1		
	p2'-p2	mbar	---	---	---	---	---	---		
EXHAUST	t3	°C	540.6	557.9	549.5	520.6	521.7	529.8		
	p3	bar	.121	.210	.233	.318	.383	.610		
	t4	°C	475	484	480	463	454	447		
	p4-p0	mbar	1.17	7.37	7.5	11.2	22	39.5		
	Smoke	bosch	---	---	---	---	---	---		
BLOW-BY		cm³/mn	159.1	265.3	277	298	442	623		

ENGINE Type: Cummins 504 N°:							Place date:	
FULL CHARGE PERFORMANCES INITIAL ☐ FINAL ☐							Reference:	
FUEL:		OIL type:					BRAKE type:	
Volume mass: kg/dm³		grade:					Full Load at 300 Hours	
AMBIENT	t0 °C	31.8	32	32.2	32.9	33.2	33.8		
	p0 mbar	1001	1001	1001	1001	1001	1001		
PERFORMANCE	n r.p.m	1400	1800	1900	2200	2600	3000		
	M m.daN	606.1	631.9	632.8	569.5	569.6	560.03		
	P kw	89.6	118.5	123.9	131.2	156.1	176.2		
	pme bar	9.3	9.6	9.5	8.7	8.7	9.5		
FUEL	Cs/bsfc g/kwh	222.1	218.4	217.2	216.5	215.9	212.9		
	Qc mm^3/cycle	70.1	70.9	70.1	63.8	63.9	61.5		
	qm kg/h	19.9	25.9	27	28.5	33.7	37.5		
OIL	tH °C	104	110	112	114	117	121		
	pH bar	3.04	3.70	3.72	4.20	4.47	4.51		
WATER	te °C	87.3	89.1	88.0	88.9	89	88.8		
	ts °C	95.3	96.4	95.9	95.7	95.8	95.7		
INLET	t1 °C	31.7	32.0	32.32	32.7	33.4	33.2		
	p0 - p1 mbar	3.95	5.17	6.06	7.50	10.39	13.8		
	t2 °C	58.9	72.8	76.4	82.4	99.6	118		
	p2 bar	.289	.371	.410	.475	.657	.846		
	t2' °C	58.9	72.8	76.4	82.4	99.6	118		
	p2-p2' mbar	---	---	---	---	---	---		
EXHAUST	t3 °C	560	576	570	539	542	553		
	p3 bar	.174	.259	.292	.341	.518	.738		
	t4 °C	488	497	496	480	475	470		
	p4-p0 mbar	.936	3.37	4.94	7.39	18.9	33.2		
	Smoke bosch	---	---	---	---	---	---		
BLOW-BY	cm^3/mn	115	198	209	215	283	414		

ENGINE Type: Cummins 504 N°:									Place date:
FULL CHARGE PERFORMANCES INITIAL ☐ FINAL ☐									Reference:
FUEL:			OIL type:						BRAKE type:
Volume mass: kg/dm³			grade:						Full Load at 400 Hours
AMBI-ENT	t0	°C	25.1	25.5	25.7	26.2	25.9	26.7		
	p0	mbar								
PERFORMANCES	n	r.p.m	1400	1800	1900	2200	2600	3000		
	M	m.daN	598.9	562.6	557.3	567.4	573.6	554.7		
	p	kw	126.2	129.6	140	154.4	168.2	174.4		
	pme	bar	13.0	10.4	10.7	10.2	9.4	8.4		
FUEL	Cs/bsfc	g/kw h	212.9	212.9	212.3	211.7	209.3	206.8		
	Qc	mm³/cycle	94.4	75.6	77.6	73.3	66.7	59.2		
	qm	kg/h	26.8	27.6	29.7	32.7	35.2	36.0		
OIL	tH	°C	111.2	112	113.1	114.7	117.6	119.3		
	pH	bar	3.99	4.32	4.53	4.60	4.56	4.57		
WATER	te	°C	89.5	89.9	90.3	90	89.8	90		
	ts	°C	96.7	96.5	96.5	96.5	96.5	96.7		
INLET	t1	°C	25.2	25.6	25.7	26.11	26.0	26.5		
	p0 - p1	mbar	6.25	7.1	8.30	9.67	11.26	12.60		
	t2	°C	69.8	74.1	81.04	90.8	101.3	109.9		
	p2	bar	.433	.472	.550	.651	.770	.850		
	t2'	°C	69.8	74.1	81.04	90.8	101.3	109.9		
	p2-p2'	mbar	---	---	---	---	---	---		
EXHAUST	t3	°C	535	516	513	521	530	532		
	p3	bar	.263	.312	.383	.480	.599	.701		
	t4	°C	470	457	451.5	451	452.1	448.2		
	p4-p0	mbar	11.34	14.45	19.7	25.7	32.7	40.4		
	Smoke	bosch	---	---	---	---	---	---		
BLOW-BY		cm³/mn	213	218	251	283.2	376	447		

ENGINE

PERFORMANCES

				Part Load at 1400 RPM						
				85	70	60	50	40	75	15
AMBIENT	t0	°C		26.9	26.9	27.6	28.0	27.8	---	27.9
	p0	mbar		1004.3	1004.3	1004.3	1004.3	1004.3	---	1004.3
PERFORMANCE	n	rpm		1400	1400	1400	1400	1400	---	1400
	M	mdaN		519.5	423.6	358.1	302.4	230.7	---	71.2
	P	kw		76.2	62.1	52.5	44.3	33.8	---	10.5
	pme	bar		7.9	6.4	5.5	4.6	3.5	---	1.1
FUEL	Cs/bsfc	g/kw h		215.9	216.6	241.0	224.6	274.0	---	416.8
	Qc	mm^3/cycle		69.3	56.6	53.3	41.8	39.3	---	18.6
	qm	kg/h		16.4	13.4	12.6	9.9	9.3	---	4.4
OIL	tH	°C		107.9	106.7	104.4	102.9	101.3	---	98.1
	pH	bar		3.0	3.1	3.3	3.4	3.5	---	3.8
WATER	te	°C		90.6	90.4	90.9	91.7	92.2	---	91.5
	ts	°C		97.5	96.2	95.9	96.1	96.0	---	94.2
INLET	t1	°C		26.9	26.9	27.6	28.0	27.8	---	27.9
	p0 - p1	mbar		3.8	3.7	3.7	3.7	3.6	---	3.6
	t 2	°C		---	---	---	---	---	---	---
	p 2	bar		.37	.28	.23	.18	.12	---	.03
	t2'	°C		---	---	---	---	---	---	---
	p2-p2'	mbar		---	---	---	---	---	---	---
EXHAUST	t3	°C		489.4	422.8	376.8	342.2	296.1	---	180.0
	p3	bar		.19	.17	.16	.14	.12	---	.09
	t 4	°C		428.7	381.5	345.1	313.1	272.1	---	170.9
	p4-p0	mbar		2.5	2.5	1.7	1.6	1.3	---	.21
	Smoke	Bosch		---	---	---	---	---	---	---
BLOW-BY		dm^3/mn		---	---	---	---	---	---	---

ENGINE

PERFORMANCES

				Part Load at 1600 RPM						
				85	70	60	50	40	75	15
AMBIENT	t0	°C		26.6	27.1	26.4	26.8	26.4	26.9	26.9
	p0	mbar		1004.3	1004.3	1004.3	1004.3	1004.3	1004.3	1004.3
PERFORMANCE	n	rpm		1600	1600	1600	1600	1600	1600	1600
	M	mdaN		534.8	439.5	379.1	313.4	255.5	163.7	76.9
	P	kw		39.5	73.6	63.5	52.5	42.8	27.2	12.5
	pme	bar		8.1	6.7	5.8	4.8	3.9	2.4	1.2
FUEL	Cs/bsfc	g/kw.h		211.0	211.8	214.2	205.9	227.0	311.6	372.5
	Qc	mm^3/cycle		69.9	57.7	50.3	39.9	35.9	31.4	17.4
	qm	kg/h		18.9	15.6	13.6	10.8	9.7	8.5	4.7
OIL	tH	°C		111.0	109.3	107.2	105.2	103.6	101.6	99.9
	pH	bar		3.4	3.5	3.7	3.8	4.0	4.1	4.3
WATER	te	°C		90.1	90.4	90.9	91.8	92.0	92.2	92.4
	ts	°C		97.3	96.3	96.1	96.2	95.9	95.5	95,1
INLET	t1	°C		26.6	27.1	26.4	26.8	26.4	26.9	26.9
	p0 - p1	mbar		4.4	4.3	4.2	4.1	4.1	4.0	4.1
	t 2	°C		---	---	---	---	---	---	---
	p 2	bar		.49	.36	.29	.23	.17	.11	.06
	t2'	°C		---	---	---	---	---	---	---
	p2-p2'	mbar		---	---	---	---	---	---	---
EXHAUST	t3	°C		502.8	441.9	400.0	359.4	320.0	257.5	196.7
	p3	bar		.26	.23	.21	.19	.17	.14	.13
	t 4	°C		444.3	396.0	362.7	326,2	293.1	237.7	183.8
	p4-p0	mbar		5.4	4.2	3.7	3.7	2.5	.61	.70
	Smoke	bosch		---	---	---	---	---	---	---
BLOW - BY		cm^3/mn		---	---	---	---	---	---	---

ENGINE

PERFORMANCES

				Part Load at 1800 RPM						
				85	70	60	50	40	75	15
AMBIENT	t0	°C		24.5	25.4	25.4	25.6	25.9	26.2	25.9
	p0	mbar		1004.3	1004.3	1004.3	1004.3	1004.3	1004.3	1004.3
PERFORMANCE	n	rpm		1800	1800	1800	1800	1800	1800	1800
	M	mdaN		525.2	435.0	371.8	309.3	251.1	152.9	82.6
	p	kw		99.0	81.2	70.1	58.3	47.3	38.8	15.6
	pme	bar		8.0	6.6	5.7	4.7	3.8	2.4	1.3
FUEL	Ks/bsfc	g/kw h		209.0	217.4	212.9	220.8	227.1	286.5	356.9
	Qc	mm^3/cycle		68.0	57.9	48.0	42.4	35.2	27.0	18.4
	qm	kg/h		20.7	17.6	14.6	12.9	10.7	8.2	5.6
OIL	tH	°C		112.7	111.4	109.1	107.2	105.8	103.3	102.1
	pH	bar		3.8	4.0	4.1	4.2	4.3	4.5	4.6
WATER	te	°C		89.9	90.6	91.1	91.7	92.1	92.5	92.7
	ts	°C		96.6	96.4	96.3	96.3	96.2	95.9	95.5
INLET	t1	°C		24.5	25.4	25.4	25.6	25.9	26.2	25.9
	p0 - p1	mbar		5.2	4.9	4.8	4.8	4.7	4.5	4.4
	t2	°C		---	---	---	---	---	---	---
	p2	bar		.60	.47	.38	.30	.23	.13	.09
	t2'	°C		---	---	---	---	---	----	---
	p2-p1'	mbar								
EXHAUST	t3	°C		492.5	443.3	403.6	367.8	331.6	262.4	210.6
	p3	bar		.34	.30	.27	.25	.22	.18	.16
	t4	°C		436.3	397.3	365.8	332.7	302.1	238.9	194.8
	p4-p0	mbar		9.2	7.6	6.4	4.7	3.1	1.6	1.4
	Smoke	bosch		---	---	---	---	----	---	---
BLOW-BY		dm^3/mn		---	---	---	---	---	---	---

ENGINE

PERFORMANCES

				Part Load at 2000 RPM						
				85	70	60	50	40	75	15
AMBI-ENT	t0	°C		27.6	22.5	22.6	22.8	22.9	23.1	23.4
	p0	mbar		1004.3	1004.3	1004.3	1004.3	1004.3	1004.3	1004.3
PERFORMANCE	n	rpm		2000	2000	2000	2000	2000	2000	2000
	M	mdaN		511.2	404.2	354.8	299.3	235.1	147.0	79.9
	P	kw		107.0	84.6	74.3	62.6	49.2	30.8	16.7
	pme	bar		7.7	6.1	5.4	4.6	3.6	2.2	1.2
FUEL	Cs/Bsfc	g/kw.h		212.3	221.8	222.0	225.2	250.6	322.6	332.6
	Qc	mm^3/cycle		67.2	55.6	48.8	41.7	36.4	28.7	16.6
	qm	kg/h		22.7	18.8	16.5	14.1	12.3	9.7	5.6
OIL	tH	°C		115.2	112.4	111.2	109.8	107.9	106.1	104.2
	pH	bar		4.1	4.3	4.4	4.5	4.6	4.7	4.9
WATER	te	°C		90.9	90.8	91.4	91.9	92.3	92.5	92.8
	ts	°C		97.2	96.2	96.4	96.3	96.2	95.8	95.7
INLET	t1	°C		27.6	22.5	22.5	22.8	22.9	23.1	23.4
	p0 - p1	mbar		6.1	5.7	5.6	5.5	5.4	5.1	5.1
	t2	°C		---	---	---	---	---	---	---
	p2	bar		.70	.52	.45	.37	.28	.18	.12
	t2'	°C		---	---	----	---	---	----	---
	p2 - p2'	mbar		---	---	---	----	---	---	---
EXHAUST	t3	°C		488.3	425.5	398.3	370.4	330.0	269.4	218.1
	p3	bar		.42	.36	.34	.31	.28	.23	.20
	t4	°C		434.1	381.7	359.9	334.1	299.1	243.8	199.0
	p4 - p0	mbar		9.5	7.1	6.7	5.9	4.7	3.4	2.6
	Smoke	bosch		---	---	---	---	---	---	---
BLOW - BY		dm^3/mn		---	---	---	---	---	----	---

ENGINE

PERFORMANCES

				Part Load at 2200 RPM						
				85	70	60	50	40	75	15
AMBI-ENT	t0	°C		28.1	25.6	26.1	26.6	26.9	27.2	27.6
	p0	mbar		1004.3	1004.3	1004.3	1004.3	1004.3	1004.3	1004.3
PERFORMANCES	n	rpm		2200	2200	2200	2200	2200	2200	2200
	M	mdaN		483.8	393.0	341.0	284.4	225.9	142.0	97.6
	P	kw		111.2	90.5	78.6	65.5	52.0	32.7	22.5
	pme	bar		7.38	6.0	5.2	4.4	3.5	2.1	1.5
FUEL	bs/bsfc	g/kwh		212.1	218.8	224.7	232.4	246.5	298.3	386.6
	Qc	mm^3/cycle		63.5	53.5	47.6	40.9	34.4	26.1	23.4
	qm	kg/h		23.6	19.8	17.7	15.2	12.8	9.7	8.7
OIL	tH	°C		115.7	113.5	112.0	110.5	109.3	107.6	106.6
	pH	bar		4.5	4.6	4.7	4.8	4.8	4.9	4.9
WATER	te	°C		90.2	91.0	91.3	91.7	92.2	92.3	92.8
	ts	°C		96.1	96.2	96.2	96.1	96.1	95.8	96.0
INLET	t1	°C		25.6	26.1	26.6	26.6	26.9	27.2	27.6
	p0-p1	mbar		6.7	6.4	6.2	6.0	5.9	5.7	5.7
	t2	°C		---	---	---	---	---	---	---
	p2	bar		.78	.60	.50	.42	.34	.23	.18
	p2'	°C		---	---	---	---	---	---	---
	p2-p2'	mbar		---	---	---	---	---	---	---
EXHAUST	t3	°C		473.1	425.8	399.7	370.6	337.5	282.2	248.8
	p3	bar		.53	.46	.42	.38	.34	.29	.27
	t4	°C		418.9	379.2	359.1	333.7	304.5	254.8	224.9
	p4-p0	mbar		11.7	9.7	8.7	8.5	7.7	6.4	5.3
	Smoke	bosch		---	---	---	---	---	---	---
BLOW-BY		cm^3/mn		---	---	---	---	---	---	---

ENGINE

PERFORMANCES

				Part Load at 2400 RPM						
				85	70	60	50	40	75	15
AMBI-ENT	t0	°C		28.5	28.8	29.0	28.6	---	---	---
	p0	mbar		1000.6	1000.6	1000.6	1000.6	1000.6	1000.6	1000.6
PERFORMANCE	n	rpm		2400	2400	2400	2400	2400	2400	2400
	M	mdaN		482.5	398.4	339.8	276.5	---	---	---
	P	kw		121.2	100.1	85.8	69.5	---	---	---
	pme	bar		7.4	6.1	5.2	4.2	---	---	---
FUEL	Cs/bsfc	g/kwh		217.3	223.1	228.8	239.6	---	---	---
	Qc	mm³/cycle		64.8	54.9	48.3	40.9	---	---	---
	qm	kg/h		26.3	22.3	19.6	16.6	---	---	---
OIL	tH	°C		117.2	115.9	114.2	112.5	---	---	---
	pH	bar		4.6	4.7	4.8	4.8	---	---	---
WATER	te	°C		91.1	91.3	91.5	92.0	---	---	---
	ts	°C		96.8	96.4	96.2	96.2	---	---	---
INLET	t1	°C		28.5	28.8	29.0	28.6	---	---	---
	p0 - p1	mbar		7.9	7.4	7.2	7.0	---	---	---
	t 2	°C		---	----	---	---	---	---	----
	p 2	bar		.91	.72	.60	.49	---	---	---
	t2'	°C		---	---	----	----	---	---	---
	p2 - p2'	mbar		---	----	----	---	----	---	---
EXHAUST	t3	°C		480.2	440.6	407.8	374.4	---	---	----
	p3	bar		.67	.58	.53	.47	---	---	---
	t 4	°C		420.7	388.5	363.8	334.6	---	---	---
	p4 - p0	mbar		16.7	13.8	11.8	9.9	---	---	---
	Smoke	bosch		---	---	---	---	-----	---	---
BLOW - BY		cm³/mn		---	---	---	---	---	---	---

ENGINE

PERFORMANCES

				Part Load at 2600 RPM						
				85	70	60	50	40	75	15
AMBIENT	t0	°C		28.7	28.9	28.4	28.6	28.5	28.7	---
	p0	mbar		1000.6	1000.6	1000.6	1000.6	1000.6	1000.6	---
PERFORMANCE	n	rpm		2600	2600	2600	2600	2600	2600	2600
	M	mdaN		486.5	397.1	342.0	283.5	228.5	133.7	---
	P	kw		134.4	108.1	93.1	77.2	62.4	36.4	---
	pme	bar		7.4	6.1	5.2	4.3	3.5	2.1	---
FUEL	Cs/bsfc	g/kw.h		216.2	227.3	234.3	246.3	264.1	312.8	---
	Qc	mm^3/cycle		66.2	56.0	49.6	43.2	37.6	25.9	---
	qm	kg/h		29.1	24.6	21.8	19.0	16.5	11.4	---
OIL	tH	°C		119.7	117.4	115.7	115.0	113.7	111.4	---
	pH	bar		4.7	4.7	4.8	4.8	4.9	5.0	---
WATER	te	°C		90.7	91.0	91.5	92.1	92.4	92.5	---
	ts	°C		96.5	96.3	96.3	96.5	96.4	96.0	---
INLET	t1	°C		28.7	28.9	28.4	28.6	28.5	28.7	---
	p0-p1	mbar		9.2	8.5	8.2	7.8	7.7	7.2	---
	t2	°C		---	---	---	---	---	---	---
	p2	bar		1.1	.85	.73	.61	.51	.34	---
	t2'	°C		---	---	---	---	---	---	---
	p2-p2'	mbar		---	---	---	---	---	---	---
EXHAUST	t3	°C		488.6	443.9	416.7	386.1	358.2	298.9	---
	p3	bar		.85	.72	.66	.59	.54	.45	---
	t4	°C		425.7	389.4	370.6	343.3	317.1	263.3	---
	p4-p0	mbar		21.5	17.1	14.7	13.3	12.0	9.3	---
	Smoke	Bosch		---	---	---	---	---	---	---
BLOW-BY		cm^3/mn		---	---	---	---	---	---	---

ENGINE

PERFORMANCES

				Part Load at 2800 RPM						
				- 85	- 70	60	50	40	25	15
AMBI-ENT	t0	°C		27.9	27.8	27.5	28.1	28.5	28.1	-
	p0	mbar		1000.6	1000.6	1000.6	1000.6	1000.6	1000.6	-
PERFORMANCE	n	rpm		2800	2800	2800	2800	2800	2800	-
	M	mdaN		490.2	402.1	343.2	289.9	230.1	141.8	-
	P	kw		143.7	117.8	100.5	84.9	67.5	41.6	
	pme	bar		7.5	6.1	5.2	4.4	3.5	2.1	
FUEL	Ks/bstc	g/kw h		220.8	232.6	239.4	252.1	269.9	322.9	-
	Gc	mm^3/cycle		66.9	57.7.	50.7	45.2	38.5	28.3	
	qm	kg/h		31.68	27.3	24.0	21.4	18.2	13.4	-
OIL	tH	°C		121.8	120.4	118.2	117.1	115.5	113.6	-
	pH	bar		4.7	4.7	4.8	4.8	4.9	5.0	-
WATER	te	°C		91.0	91.0	91.4	91.8	92.1	92.3	-
	ts	°C		96.9	96.4	96.4	96.4	96.4	96.1	
INLET	t1	°C		27.9	27.8	27.5	28.1	28.5	28.1	-
	p0 - p1	mbar		10.6	9.9	9.4	9.0	8.7	8.3	-
	t 2	°C		-	-	-	-	-	-	-
	p 2	bar		1.3	1.0	.88	.76	.62	.44	-
	t2'	°C		-	-	-	-	-	-	-
	p2-p2'	mbar		-	-	-	-	-	-	-
EXHAUST	t3	°C		495.3	452.2	423.9	397.5	367.8	314.3	-
	p3	bar		1.1	.91	.82	.75	.67	.56	-
	t 4	°C		423.8	392.2	371.3	349.4	323.1	278.1	-
	p4 - p0	mbar		28.0	26.1	20.2	17.9	15.7	12.4	-
	Smoke	Bosch		-	-	-	-	-	-	-
BLOW - BY		cm^3/mn		-	-	-	-	-	-	-

ENGINE

PERFORMANCES

				Part Load at 3000 RPM						
			85	- 70	- 60	50	40	25	15	
AMBI-ENT	t0	°C	26.3	26.4	26.5	26.7	26.7	26.8	27.0	-
	p0	mbar	1000.6	1000.6	1000.6	1000.6	1000.6	1000.6	1000.6	1000.6
PERFORMANCE	n	rpm	3000	3000	3000	3000	3000	3000	3000	-
	M	mdaN	468.9	384.7	327.6	275.9	216.0	146.7	124.2	-
	P	kw	147.3	120.8	102.9	86.7	67.8	46.1	39.0	-
	pme	bar	7.2	5.8	5.0	4.2	3.3	2.2	1.9	-
FUEL	Ks/bsfc	g/kw.h	227.7	238.5	251.3	263.5	294.4	346.5	372.4	-
	Qc	mm^3/cycle	66.1	56.8	50.9	45.0	39.4	31.6	28.6	-
	qm	kg/h	33.5	28.8	25.8	22.8	20.0	16.0	14.5	-
OIL	tH	°C	124.9	122.6	120.9	119.4	117.3	115.9	114.5	-
	pH	bar	4.7	4.7	4.8	4.8	4.9	5.0	5.0	-
WATER	te	°C	90.5	91.0	91.3	91.6	92.1	92.5	93.3	-
	ts	°C	96.7	96.5	96.4	96.4	96.5	96.5	97.0	-
INLET	t1	°C	26.3	26.4	26.3	26.7	26.7	26.8	27.0	-
	p0 - p1	mbar	11.9	11.1	10.6	10.1	9.7	9.1	9.0	-
	t 2	°C	-	-	-	-	-	-	-	-
	p 2	bar	1.4	1.2	1.0	.87	.73	.56	.52	-
	t2'	°C	-	-	-	-	-	-	-	-
	p2-p2'	mbar	-	-	-	-	-	-	-	-
EXHAUST	t3	°C	494.7	455.3	428.1	402.4	372.6	332.2	319.7	-
	p3	bar	1.3	1.1	.98	.89	.80	.68	.66	-
	t 4	°C	419.4	389.0	369.6	349.2	323.4	291.0	277.9	-
	p4 - p0	mbar	34.2	28.7	24.5	22.7	19.6	16.2	15.7	-
	Smoke	bosch	-	-	-	-	-	-	-	-
BLOW - BY		cm^3/mn	-	-	-	-	-	-	-	-

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